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DENSITY PLUMMETS

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Density plummets provide one of the most impressive ways to draw attention to the peculiar density-temperature relationships of water with the accompanying biological and climatic significance. The construction of the plummets presents enough difficulty to keep the best handy men among the pupils busy an hour or so. Yet the glass working technique is not so difficult but that the "butterfingers" can complete them. The completed plummets are beautiful—graceful in shape and behavior—fascinating to all who watch.

The plummets may be made of test tubes of any desired size or of electric light bulbs. They may be weighted with mercury, shot, sand or water, the last being recommended. For a student project small test tubes are best because they require so little water to float them. For large scale demonstration purposes, electric light bulbs have obvious advantages.

The first step is to draw the test tube in the middle until it has a neck about one-sixteenth inch in diameter. The neck should be big enough so that the plummet can be filled easily through it and small enough so that there will be very little change in total volume when the neck is sealed.

I find it best to heat the test tube in a Bunsen flame and pull it until the diameter is reduced by a quarter or a half. It is easy then to heat the thin place until the glass is very soft. The tube is then removed from the flame, held vertically, and pulled.

That is somewhat easier to say than do. It is at this stage that is born the straight, or crooked, thick or thin neck. If the pull

is too sudden the neck will be too long and thin. It is well to pull until the neck is the right size and as soon as the neck hardens, which will be in a fraction of a second, pull again to thin down the shoulder. This shoulder, being thicker, remains hot and soft longer than the neck.

Cut the neck so that it is half an inch or an inch long. A crystal of carborundum is much more satisfactory for this purpose than a file. The neck is too thin for a file and will crush. The carborundum makes a fine, hairline scratch at which the glass breaks square. Perhaps a diamond would do as well.

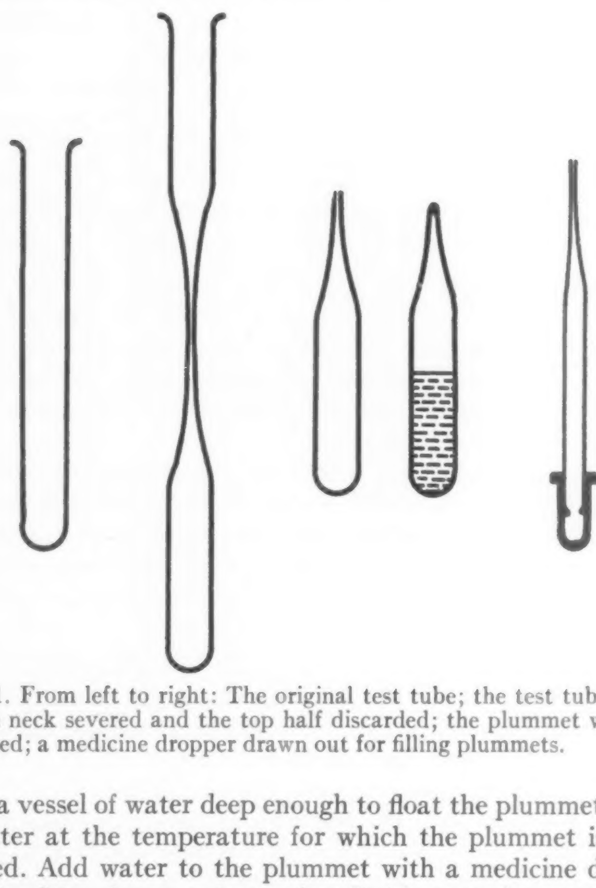

FIG. 1. From left to right: The original test tube; the test tube drawn out; the neck severed and the top half discarded; the plummet weighted and sealed; a medicine dropper drawn out for filling plummets.

Use a vessel of water deep enough to float the plummet. Keep the water at the temperature for which the plummet is to be designed. Add water to the plummet with a medicine dropper which has been drawn out very fine. Put in enough water so that the neck will float just flush with the surface. If the neck of the plummet contains no water, the plummet may be removed from the vessel and its neck sealed in the flame. If there is water in

the neck blow in it to remove the water and then check its floating level again; a very small amount of water makes a great difference in performance. When sealing use very little of the flame and roll the neck so that it will seal symmetrically.

The plummet will probably float in the water you have been using but will sink in water a few degrees warmer. Use a thermometer to determine its critical temperature. This will be constant and may be marked on the plummet with a grease pencil.

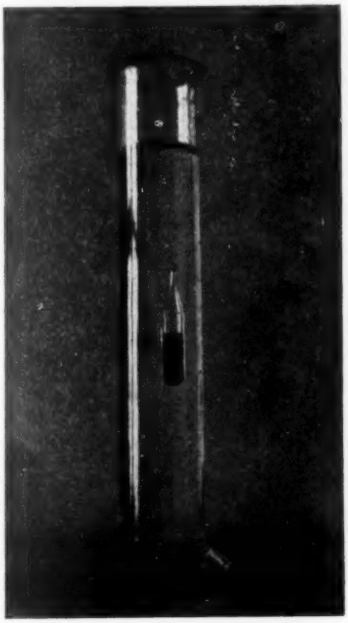

FIG. 2. A plummet brought to almost perfect balance by adjusting the temperature of the water.

If the plummet is to be set up for exhibition purposes, use boiled water. Otherwise air bubbles will cling to it and float it at too high a temperature.

Most students prefer to color the water they put into the plummets. Ink is quite satisfactory.

I have in the laboratory a 50 mm. glass tube five feet long filled with water containing plummets floating between 15° and 21°C. Sometimes they are all floating when we arrive on a cold winter morning. We like to watch them sink one by one as the

water warms up. It takes fifteen minutes or so for one to make the journey from top to bottom.

Those who have more than average skill and patience may like to try making a plummet that will float at 4°C. but sink if the water gets either colder or warmer. This is a delicate job—so delicate that a plummet made for one sample of tap water will not work in water from a different source. Small differences in dissolved minerals will change the temperature at which the plummet rises and sinks.

First then, choose your water and stick to it. Snow water or distilled water might be most satisfactory in some cases. Prepare a sample of water at 4°C. and fill the plummet until it floats flush. Then seal the neck and say a little prayer. If it floats but sinks when you cool the water you are finished. This is not likely to be the case.

If it does not sink its volume may be reduced by keeping the air in the sealed plummet cold while you are heating the tip end. It will shrink because of the reduced pressure inside.

If the trouble is that the plummet sinks at 4°C., then warm the air in the plummet with your hand while you heat the tip end. If you are very careful, you will blow a tiny bubble at the end thus increasing the volume. If you are not careful, the bubble will burst and you will need to seal the neck again with the chance of spoiling the work entirely.

After many tries you may succeed in getting a plummet which will float at 4°C. and sink at other temperatures. It usually takes me an hour to make the final adjustment and I find that I spoil about half of them.

BIRTH RATES IN WARTIME

"The effects of the present war on birth rates have been much more varied than in World War I," Dr. Louis I. Dublin, of the Metropolitan Life Insurance Company, told the American Public Health Association.

Russian and German birth rates have been most seriously affected and their military losses have been the heaviest of all belligerents, he reported. The French birth rate has fallen but not to the low level of the first World War. In the Netherlands and Denmark, the birth rates have actually increased above prewar levels. The birth rate in the United States has increased to the highest level in 20 years, but a sharp reduction in 1945 is expected because so many young men are overseas and likely to remain there for some time. England also has experienced a war boom in births, with this year expected to put the rate at its highest figure for 15 years or more.

MATHEMATICS TUNED TO THE TIMES

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It is a foregone conclusion that we have passed beyond the "horse and buggy" days. It is no longer necessary to elect our President in November, giving him until March to learn of his election and to make the trip to Washington. No other "battle of New Orleans" will be fought two weeks after a treaty has terminated the war.

Likewise, in the field of mathematics, great advances have been and are being made. So much has been said on the subject, and those administrators and teachers concerned with the problem of keeping mathematics up-to-date are so aware of the immensity of their task, that it ill behooves this discussion to dwell at length on that phase of the subject. Rather, let it suffice to recognize the ever-changing conditions, admit that the goal is rapidly receding, and let mathematics instructors and administrators strengthen their position in that they know what they are pursuing.

William L. Hart, University of Minnesota, says, "Our nation is justified in demanding that we should always have on hand a relative surplus of people with mathematical training for emergencies."[1] Such a statement is accepted now by reason of the present emergency. Too much time is spent, after induction, on common and decimal fractions, proportion, measurement, and the solution of formulas. The graded public school must concern itself with the development of citizens who know how to deal intelligently with the problems of modern life. It should be impossible for the graduates of secondary schools to be quantitatively illiterate. The technical advances of civilization require much mathematics.

The pendulum has been swinging away from this emphasis and, but for the war, would have begun the return swing in a few years anyway. The advent of war suddenly stopped the swing, and the problem of mathematical deficiencies among those inducted into the armed forces has had to be faced squarely by those who administer the schools of this nation. Since the Army and Navy training programs have very specifically brought this matter to the forefront, much comment

[1] Hart, William L., "The Nation Calls for Mathematics," SCHOOL SCIENCE AND MATHEMATICS, February, 1943, p. 116.

and some activity have been noted on the part of schools generally. Mathematics refresher courses and various other types of pre-induction courses have been added and, in a measure, have met the need and dispelled the criticism.

Those who feel responsible for or are desirous of improvements in our educational curriculums are pretty well agreed that most high school seniors have not acquired sufficient knowledge of, or skill in the use of, a workable number system. They are unable to delve back into their number study experience and bring forth the best way to express the quantitative idea. Many students have viewed a number as an end in itself, rather than as a means of expressing an idea of size, quantity, or value. This cannot be justified, but it is easily explained.

There came a time in education when someone critically evaluated all the monotonous drill being done in grade school. 18×18 is 324, but who cares? So, out went the time tables. Cube root was pared off, and justly too, but the cutting process, once started, was not easily arrested. Then came the days of the "Core Curriculum," with special emphasis on the social studies. Physical education, health, music, and art were accorded a rightful share of the student's attention. These moves, coupled with the depression and the subsequent dearth of opportunity in such fields as engineering, have reduced the time formerly given to mathematics, with a corresponding decline in the quality of number study.

It is within the scope of this discussion to survey what has been done and to outline possible solutions of the problems which, though called by name by reason of war, have been always present.

Criticism of education is by no means new. The ordinary man believes that:

"He was forced to learn too many things, or too few. It was all too general; or too special. The present was ignored; or the past. Something was left out entirely. . . ."[2]

In the face of this critical attitude it is not easy to fix the blame. Grades three to eight are normally charged with the responsibility of the four fundamentals, as well as fractions, decimals, and percentage. Arithmetic, as taught, separately, and in order, takes up first one item, then another, as an entity rather than as a part of the whole. Under such a system, the purpose of the drill is forgotten in the process of doing the drill. In this

[2] Van Doren, Mark, *Liberal Education*. Henry Holt & Co., New York, 1943, p. 2.

connection, Van Doren comments, " . . . but then if a right relation is maintained between detail and principle, the detail will not be forgotten."[3]

Not even the most ardent critic of mathematics has claimed the subject was not taught. It is claimed that, as taught, mathematics is not useful in the ways it is now needed in war training programs nor is the practical application of a process recalled when, in the course of ordinary peace-time pursuits, the young man or woman meets a number situation.

The problem then becomes more clearly a need for review, summarization, integration of number concepts, and consolidation of meaningful information. In this review, the first objective should be toward simplification, striving to get the students to use the easiest forms and operations. For example, too many people divide by 6 by long division. They would never think of dividing by 8 twice instead of 64 once. They hit the paper four times to add a 4. They make big work of multiplying 1000 by 795, instead of juggling a decimal point. They would not recognize 62.5 as $\frac{5}{8}$ of 100. They would do each operation as they approached it, rather than setting up the whole solution as indicated operations and, after a bit of cancelling, doing the remaining parts only.

If, at the end of the eighth grade, or late in high school, these laborious processes could be replaced with a more logical, simpler, and shorter approach, then the results of number work would be greatly improved. If the young housewife can decide in a hurry which is the bargan, 4 for 17¢ or 6 for 27¢, or can select a 14 oz. can at 11¢ or a 1 lb., 4 oz. can at 14¢; if a girl is clerking and can keep ahead of the customer in price fixing; if the salesman can arrive in time to figure out what he is going to say next while his prospect is getting the answer; she or he will succeed in a measure far exceeding those who cannot.

"A series of experiments have shown that a short period of practice produces a marked growth among high school seniors."[4] This alludes to arithmetical abilities and is occasioned by wartime needs. That which is essential for some in the present crisis might well be valuable for all throughout the years. No mathematics course, now included generally as part of the secondary school curriculum, provides the necessary review. Those students most in need of such a refresher course have not been

[3] *Ibid.*, p. 8.
[4] Brueckner, Leo J., "Mathematics to Serve War Needs," *Nat. Ed. Ass'n J.*, October, 1943, p. 203.

taking any high school mathematics. Both now and in the future there is great justification for a course in the senior year of high school which reviews fractions, decimals, measurement and scale drawing, use of simple formulas and equations, ratio and proportion. At the close of the junior year, a type of arithmetical test[5] could be used, requiring all who fail to meet a given standard to take this mathematical review. Such a plan could leave algebra and geometry where they have been, as ninth and tenth grade electives. It would not greatly concern those students who have succeeded therein.

Such a course could even include, as an optional part, some geometry with emphasis on the informal presentation, the right triangle, and the trigonometry of the right triangle. It had better not attempt to cover the "trig" of the scalene triangle, slide rule and logarithms.

This approach would more nearly guarantee a minimum number efficiency on the part of those participating. It could be expected to greatly improve the mathematical ability of high school graduates as they move into further training or go directly into the more usual vocational pursuits.

This reasoning is concluded with these deductions:

1. The problem of mathematical deficiency, which the war training program has decried, was present, is present, and must be met in the post-war period.
2. Technological advances have apparently required a high degree of mathematical skill in the expert, but in reality they have made it essential that all people be able to meet a more complex number situation.

These deductions lead to the following recommendations:

1. A greater part of grade school arithmetic should be presented with emphasis on its functional usefulness and practical applications.
2. In summing up and reviewing arithmetic, a more definite attempt should be made to relate the parts and to present the study of numbers as one complete meaningful system.
3. What is now known as "Refresher Mathematics" should be given to a larger part of the senior class, both boys and girls, and should be looked upon as a permanent part of the curriculum.

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[5] Such as "Standard Achievement Test," Advanced Arithmetic Test, Form G.

SOME EXPERIENCES WITH TEACHER-PUPIL PLANNING OF LABORATORY WORK IN CHEMISTRY

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There are probably more problems to be met and more teacher mistakes committed in connection with laboratory work in science classes than in any other phase of school activities. Laboratory work has been accused of every weakness from creating wasteful laziness to being a mere fill-in activity for the teacher. Research has given us the answer to many of these problems, and teachers are still groping to solve other troublesome situations. Teacher-pupil planning of laboratory work offers a partial solution in many of these aspects.

It must be admitted at the outset that teacher-pupil planning of all educative experiences may be the goal of some teachers while other teachers desire to remain the kingpin and direct all activities arbitrarily by themselves. This article purports to cite some advantages of a middle way, wherein some teacher-pupil planning has been used, and has indicated desirable educational opportunities for pupils. True it is, that this report covers nothing especially unique or novel, but perhaps it may pull together some generalizations of interest to teachers which have been gained from extensive trials. Many areas of school work have doubtless experimented similarly.

It was decided to attempt to make comparisons between the effects of one method of teacher-pupil planning and one of exclusively teacher planning with different high school chemistry classes on selected units. For example, one class would do a series of experiments on a unit, chosen from the regular laboratory manual in use by the school, while another class would plan its laboratory work and write its own experiments with instructor assistance. This summarization covers only the teacher-pupil planning activities.

Twenty-six different high school chemistry manuals and eight general college chemistry manuals were purchased or borrowed. In all cases, the laboratory work preceded the classroom treatment of a unit of material in an effort to make laboratory work truly a discovery period.

As an introduction to a new unit, class time was given to

planning just what was to be done in laboratory work. Since no set laboratory days were scheduled or observed in general practice, it worked no hardship on routine of classes. The pupils first discussed what they knew in advance about the topic, followed by things they thought they might like to find out or determine. Objectives and purposes were listed through student contributions. Then the thirty-four manuals were passed out and the pupils browsed through two or three manuals in rotation, limiting their scrutinies to experiments connected to the unit being planned. Ideas were gathered and some general notations made. Various committees were appointed by a student chairman to assimilate material and organize certain phases. The manuals were then taken up and the material was re-discussed before any writing in permanent form was developed. In no case was material taken out of any manual, directly, but rather a major concept or generalization formulated. An editing committee brought together all of the material presented by various committees and the experiment was mimeographed. The pupils then performed the experiment and later went back over it to evaluate and make improvements. The thirty-four manuals were again perused to see that no significant ideas were overlooked. It was left in the best possible form for future classes to leaf through. The pupils found that they had made many mistakes, and had included some unworkable situations. These, too, were mentioned in recommendations for further improvement. Since all deficiencies apparent to the experimenting groups were corrected as diligently as possible, in later trials typical deficiencies were highly minimized.

Certain limitations of this procedure appeared quite obvious:

1. The pupil ability is often not capable of understanding reactions adequately to plan them ahead. This, however, was surprisingly limited.
2. Initial attempts often seem poorly done, but rapid improvement became evident.
3. The process is quite time consuming, thus probably should be limited to a few attempts per semester.
4. There may have been extraneous factors affecting the entire picture.
5. The classes were rotated. The one which did the routine procedure later planned its own, while the teacher-pupil planning group went about the routine method. The rotation may have created some confusion among students.
6. It may not be possible for an instructor to make accurate comparisons between groups. The classes were not homogeneously grouped.
7. There are some units in which the background appears to make it impossible to observe this practice and for which this procedure should be omitted.

8. Some of the discovery element was eliminated by this method, because more answers may have been anticipated.
9. There may be sizes of classes or systems of organization where this procedure is impractical.
10. Careful scrutiny must be maintained to avoid plagiarism.
11. The procedure may cause objections among writers and publishers of manuals. This may be answered by the probability that it should stimulate the sale of manuals, because in addition to a regular adoption, it should cause purchase of more supplementary ones. Doubtless many teachers write their own experiments by reference to several standard manuals and have them mimeographed anyway.
12. Care may need to be exercised lest the teacher become functionless and the pupils take over a little too far.
13. A very few parts of some experiments originating with pupils and incorporated into their work might not seem significant to a trained individual in science.
14. Other weaknesses are probably evident to trained investigators.

Certain advantages seemed evident and significant:

1. Correlation with other subjects seemed improved. Mathematics practice in computing amounts of materials needed was gained. More respect for use of good English, clear concise directions, and social repercussions of certain chemical reactions on civilization added to the social science interest feature.
2. There was more desire to bring everything up to date with modern applications and uses. Current magazines and printed materials were voluntarily browsed more heavily in search of additional aids. Many interesting and practical experiments were picked from current reading which have not occurred in any regular manual.
3. The textbook treatment seemed more vitalized. A higher percentage of pupils willingly participated in all aspects of the class plans.
4. The pupils were more prone to look for applications in home chemistry and industrial and local community applications, as well as more interesting phases.
5. More student conferences grew out of this type of work; more spontaneous projects grew out of the class work after this type of laboratory practice.
6. There were great gains in being able to summarize principles involved, formulate criteria, seek limitations of procedure via constructive thinking.
7. Better personal technique seemed to result, with less waste, more cleanliness and accuracy, more evaluation of each other's methods, better organization of effort, better timed planning, better choice of equipment, and more anticipation of needed cautions.
8. There seemed to be a great gain in social values; they learned to work together as a committee with critical thinking and constructive criticism of each other's work from an analytical point of view.
9. Chemistry problem work was more realistic and interesting as they tried to compute amounts and concentration of materials needed.
10. Recall seemed to be improved as evidenced in varieties of tests. Laboratory work seemed better correlated with the rest of the class work with elimination of the two-subject complex between class work and laboratory work so often prevalent. Less material was taught, but it seemed to be taught better.

11. The pupils seemed better able to understand just what basic principles are and how facts help mould a principle.
12. The practice of formulating thought questions at the end of laboratory work and practical problems based on the experiment was vastly improved. They like to build their own. Also better types of thought questions were evident with as many as fifteen distinct types being submitted for selection.
13. More spontaneous reports on related topics came back for class work.
14. A more willing pupil demonstration of certain parts developed, and they were more anxious to take practical experiments to other parts of the school system for presentation of a well-planned demonstration of applicable materials for junior high or grade science classes.
15. There was more committee work outside of class on special related topics.
16. There was greater ability to make a personal notebook more effective.
17. The function of the instructor during lab was clarified. There was more opportunity for friendly cheerfulness and thoughtful interest in what the pupils were doing. The pupils knew better what they were doing and were more willing to discuss with the instructor any phase of the experiment.
18. The dull-normal pupil problem became less apparent, since more of them found something they could do and delighted in doing it well. There were many tasks connected with the planning which they delighted in doing.
19. More home laboratories and home experimentation grew out of this practice.

Some hoped-for values of the experiment:

1. The experience gained should be closely related to training for life situations.
2. There should be more appreciation of the contribution of chemistry to civilization.
3. There should be greater inter-departmental cooperation.
4. It may create more chance for continued interest in chemistry in later life, thus yielding carry-over values.
5. It may cause more younger pupils of science to select chemistry as a course when they enter high school.
6. It may produce a better type of analytical and practical thinking.
7. It may make laboratory work more functional in daily living as an additional problem solving practice.
8. It should help justify laboratory work in the minds of those who doubt its value in school experiences.
9. It should help chemistry retain its place in the curriculum without being emasculated, blended, and absorbed into fusion courses.

It should be admitted that this does not represent a cure-all for the problems we face. Many difficulties in laboratory work are yet perplexing, and there may be better means to meet some of the situations herein listed. Admittedly, the process can be overdone and the teacher still needs to exercise caution, direction, and keep his fingers on the pulse of the program at all

times. It challenges the best abilities of a teacher rather than acts as an automatic computer for his problems.

A number of teachers have had good results with this type of technique and it is hoped that others may try it, thus throwing more light on our common problems, thus improving science education.

PHASE DIFFERENCE MICROSCOPY

A new increase in visibility through the microscope was demonstrated at the Cleveland meetings of the American Association for the Advancement of Science. The report was made by Dr. A. H. Bennett, Director of Research and Dr. O. W. Richards, Research Biologist of the Spencer Lens Company, Scientific Instrument Division of American Optical Company.

The method of obtaining the increased visibility was described some years ago, but equipment to make it practical has just been devised. The Spencer contribution extends the method to the general case, the discovery that absorption may be as or more important than retardation, the preparation and use of a wide range of phase discs of both positive and negative types, and improved methods for coating the thin films in the manufacture of the phase plates.

Improvement in the visibility of many transparent materials and organisms is claimed. Many living cells, tissues, microorganisms and industrial materials are so transparent that nothing can be seen when they are observed with the regular equipment. Due to the fact, however, that their internal structures usually do have differences in refractive index, these differences can be changed from phase differences to intensity differences. This is done by illuminating the specimen with a hollow cone of light and using a retardation plate within the objective. They can be observed or photographed in the usual manner.

The method is called Phase Difference Microscopy.

POSTWAR JOBS

Postwar employment prospects in 16 occupations are described in 16 different six-page Occupational Abstracts just revised and published by Occupational Index, Inc., New York University, New York 3, N. Y., at 25¢ each.

The occupations covered are:

Building Contractor	Plasterer
Rural Teacher	Air Conditioning Engineer
Detective	Patternmaker
Cabinetmaker	Landscape Architect
Radio Service	Bus and Truck Driver
Window Display	Linotype Operator
Butcher	Accountant
Free Lance Writer	Architect

Each abstract summarizes available information on the nature of the work, abilities and training required, earnings, number and distribution of workers, advantages, disadvantages, and postwar prospects. Sources of further information and best references for additional reading are included.

SUCH, IN PART, IS LIFE

A VIEWPOINT ON SEX EDUCATION AND HUMAN CONSERVATION

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All human beings should have some understanding of the phenomenon known as life. Many persons interpret it by prejudice, ritual, and precept rather than by an intelligent inquiry. This article should provide teachers with facts about living organisms which may be useful in understanding, and in helping others to understand how the stream of life is continued through the ages. This involves studies not only of individuals but of how other individuals are produced. While it is not intended that sex education be emphasized solely, it must be a part of the academic study and should be a part of the study of social welfare.

When illegitimate births are on the increase in the United States as a whole, and are more numerous in rural areas than elsewhere, it is desirable that any publication directed toward the betterment of conditions in general should recognize the problem. According to the Census Bureau, illegitimate births to each 1000 births in the entire United States were, before the war, 39.2; for cities larger than 10,000, 39.4; for towns of 2400 to 10,000, 30.5; and for rural areas, 41.9.

Whether the problem should be handled by the school or by the home is a matter to be determined locally. If a community or smaller group feels that it is handling the problem satisfactorily, the material need not be used extensively. If, on the other hand, it is desired that teachers help all the children or some of the children to understand themselves, it seems only reasonable that a non-commercial educational publication should provide suggestions for the solution of the problem.

There should be no doubt but that, in the realm of social health education, some form of sex education is important. When we learn that in 1938, 1347 illegitimate children were born in New York City, it would seem that there is need for some help. One out of fourteen of these were born to girls of sixteen years or younger; two were born to girls of thirteen, and one each to girls of twelve and eleven. In the first eight months of 1938, New York City's Department of Health reported 2388 cases of venereal disease in children under nineteen years of

age. It seems as though something is wrong either with the type of education these children were getting in the schools, the churches, the homes or the streets, and none of these institutions can free itself of blame by placing responsibility on any or all of the others. In a thousand cases of rape studied in New York City, the largest group of victims were sixth-grade girls, most of whom explained their predicament by saying, "I didn't know what it was all about." This article is written in the hope that it may provide help to those teachers who wish to assist in this problem.

An understanding of the problems here raised should be significant in dealing successfully with almost any living thing whether this is a domestic mammal, a plant or even a microorganism. It is written in the hope that it may make life more beautiful and less sordid than it may seem to have to be to many. There is no thought of maliciously destroying innocence or ruining idealism. Rather, it is hoped that understanding may be provided whereby more human beings may get that greatest joy of living which comes to those who are able to an increasing degree to be "masters of their fates." No one is more deserving of pity than the one who faces needless difficulties because of lack of information which could be made available and no one is more entitled to censure than he who fails to help others to the best of his ability.

This article is written not as a criticism of those who would educate their children by the methods which have been so long customary but to help those who may wish to use other means. There are plenty of books and pamphlets which come into the home and school which are not used. Those who may disagree with the philosophy here presented need only discard this article and accept responsibility for handling this dynamic situation in their own community in their own way. The author feels he has some responsibility in helping those who wish help on this problem and is by this means trying to satisfy that obligation.

A Point of Departure

For ages, philosophers have discussed which came first, the chicken or the egg. And so, in bringing up this subject of the life cycle, it is difficult to know where to begin.

One might begin this article with citing that "In the spring a young man's fancy lightly turns to thoughts of love," but the subject is too important to be handled flippantly and it might be

well to understand whether it was normal or abnormal for this sort of thing to happen to the young man. Certain it is that normally after a plant or animal has arrived at a stature characteristic of its species it may take on some new behaviors and sensations and some new obligations. During the earlier years, the creature has been essentially engaged in increasing in volume and possibly in useful experience. Education should provide the experience. Normal health and freedom from starvation and injury should provide the stature.

During the formative period, frogs have grown from eggs through the tadpole stages, have taken on the form of the adult and may have spent some years in becoming sexually mature. Many birds spend more than a year reaching a stage where they put on the plumage of the breeding adult. For example, immature, male red-winged blackbirds do not have the full yellow and red epaulets of the breeding birds; immature male redstarts have the olive and yellow plumage of the females and other species have similar periods of time in which the animals have the size of the adults but lack some of the conspicuous characters of the breeding animals.

Consideration of the life story, and the child's understanding of it, might start by learning to recognize the superficial differences which exist between the different sexes. There is little need at this level, or for the average person to understand the great maze of morphological internal anatomy which is the mechanism by which the new individuals come into being.

Sex Differences in Animals

But to begin this study, make surveys of as many of the available living things as possible to recognize the major sex differences. As a starter, outline the conspicuous sex differences between a rooster and a hen and see if these differences are as conspicuous in the pigeons, geese, and guinea fowls as they are in turkeys, mallard ducks, and pheasants.

Among the commoner birds, the following have the males and females normally looking much alike: chickadee, horned lark, starling, crow, meadowlark, red-headed woodpecker, killdeer, catbird, blue jay, kingbird, chimney swift, great blue heron; and the tree sparrow, vesper, song, chipping, and white-throated sparrows.

Birds in which there are rather inconspicuous but real super-

ficial differences include the nuthatch, bob-white, ruffed grouse, flicker, mourning dove, sparrow hawk, yellow warbler, and snowy owl.

There should be little difficulty in distinguishing at a distance, in the breeding season, the males and females of the following: bobolink, rose-breasted grosbeak, goldfinch, oriole, scarlet tanager, cowbird, red-winged blackbird, English sparrow, and humming bird.

It is unwise to generalize in pointing out these differences because in some the male may be the larger or the brighter while in others this may be reserved for the female. In one of the phalaropes, for instance, the male who attends the nest is the dull, inconspicuous bird while the female who does little but lay the eggs is much the more conspicuous.

With the mammals, the sex differences are the most conspicuous probably in the horned species where the males commonly show the horns and almost invariably when mature have their testicles in the scrotum outside the body cavity. This scrotum development is also true of the other hoofed animals such as the horses which have no horns, of the dogs and foxes, of man and monkeys and of many other species. In these species, the mammary glands are usually conspicuous on the females, particularly while they are nursing young. Relative size is no general sex-distinguishing characteristic for the mammals because with some the females are the larger and with others the males are the larger. The presence of horns is not always a safe character to identify the males because female antelope, caribou, domestic cattle, some sheep and some other animals are horned as are the males. There may be a difference in degree of development of these horns.

In the lower animals such as the reptiles, amphibians, fishes and the invertebrates, there are many in which there are conspicuous sex differences while in others there is little external evidence of difference. Recognition of these differences might well be the initial step in understanding the story of reproduction. If one wishes to raise guppies in an aquarium, it is essential that one be able to recognize the small males with their ventral fins modified into intromittent organs for placing sperm in the female for fertilizing the eggs. Similarly, if one wishes to start to raise any other pets, some ability to recognize sex differences is needed.

Some sex differences are conspicuous in some kinds of animals

from the time they appear first as individuals. With others, these do not appear until the animals are ready for reproduction. With still others, they may be developed secondarily and appear only during the breeding period.

Unfortunately in chickens everyone cannot identify day-old chicks as to their sex. Were this possible the egg farms would be saved the expense of the rearing of cockerels in excessive numbers. As the birds grow older, however, the males develop a different plumage, voice, spurs and wattles. An individual hen which lays may be made to develop the external characters of the rooster. Normally, these secondary sex characters in chickens appear about the time the bird becomes sexually mature and continue unchanged through life. In mammals, the internal glands which are responsible for these changes function variously through life and even before birth takes place.

Many wild birds, as the goldfinches, scarlet tanagers, and orioles wear a nuptial plumage during the mating season. At other times of year there seems to be little external difference between the sexes of these species.

In fishes, the horned dace, trout, red-sided minnows, black-nosed dace and common shiners show males with brilliant colors during the breeding season. In addition, some of these, like the horned dace, develop peculiar tubercles on the head and fore-parts which may be of use in holding the female during the breeding act.

Some of the amphibia, such as the frogs and salamanders, show males with definite external structural differences useful in the mating act, or apparently unimportant color differences. The temporarily larger thumbs of the male pickerel frogs and leopard frogs, the horny developments on the hind legs of male newts might be some functional structural differences. The black throats of male tree toads and common toads and the yellow throats of some male frogs might be thought of as some of the apparently non-functional sex differences. Frog and toad choruses are produced by male voices only.

Reptiles may have either functional or non-functional sex differences. Female snakes are commonly the larger; in turtles the lower shell of the male may be shorter or more concave or the tail may be longer. Male box turtles have red eyes; the eyes of the female, yellow; male spotted turtles have dusky jaws, the jaws of the female are yellow. These are unimportant functional differences.

Insects show functional and non-functional sex differences. Many of the moths, as the luna, cecropia, promethia and polyphemus have conspicuous sexual differences which may help to bring individuals of different sexes together. If there is a difference, the abdomen of the female is usually the larger; if there is a further difference, the antennae, which must be sensory organs, are larger in the males than in the females. Male mosquitoes, too, have larger antennae, as do male honey bees and males of many other species.

In human beings, the lower pitched voice and facial hair of the males are sex differences of no particular functional value, now that safety razors have made handlebar mustaches lose their appeal to the opposite sex.

Sex Differences in Plants

Almost everyone can recognize that in a corn plant there is a tassel and an ear. From the tassel, a dust-like pollen falls on the silk of the ear. When this happens, the pollen dust will begin to grow, encouraged in part by secretions of the silk. If all goes well, a grain of corn will develop at the base of each silk on which pollen has fallen and developed. Those silks that were not touched by the pollen will not develop grains of corn at their bases. In some plants, such as poplars, some maples and rues, the pollen-producing flowers are borne on plants different from those bearing seed-producing flowers.

From a functional standpoint, this is much the same as what takes place when a male animal brings its real male element, the sperm, to the real female element, the egg, in the female. Technically, this is not quite true. For our purposes, it is sufficient to suggest that each pollen grain eventually produces two sperms. One of these is responsible for the development of the embryo or "germ" of the corn grain. The other figures in the development of the area storing most of the food in the grain. Because of the fact that these areas develop from a mixture of the plant which produced the silk and the plant which produced the pollen, each will have at least some of the characters of both parents.

There is nothing magical or mysterious about the essentials of how fertile seeds are produced by plants and there is no reason why every elementary school child should not at some time control the ancestry of some plant.

This article might be used in the schools in September. At that time, there should be flowering in the neighborhood of the school

some plants such as petunias, morning glories, nasturtiums, salvias, timothy, narrow-leaved plantain, broad-leaved plantain, alfalfa, evening primroses, chickweeds, shepherd's purse, or maybe some mustards, hollyhocks, round-leaved mallows, or the like. Take time to examine many of these plants. In each, the part of the flower that produces the seeds is in the center though there is great variation in its size and shape. In some, this pistil is short and stout. In others, it is long and slender. In some, it is straight. In others, it is crooked, but in each the important part in the early stages of the pistil's life history is at the tip. This is either sticky, finely feathered, or shaped like a scraper and is so shaped that it can easily and effectively hold pollen which may come to it.

One of the best groups of plants to work with is the mallows, including the hollyhocks, because they are so large. The "cheeses" of the garden walk will do as well. In a young mallow blossom, the upper parts of the pistils are at first completely hidden by a tube of stamen bases. As the flower grows older, the pistils force their way outward through the stamens. They then spread around and may eventually mingle with the stamens themselves. In fact, they are so fixed that at first they cannot possibly receive pollen from the parent plant. When they first come into sight, they are separated from the stamens somewhat and can easily get pollen from other flowers since they are so placed as to be the first part of the flower touched by a visiting insect. If no insect pays a visit, they can still get pollen by bending back and touching pollen from the parent flower if any is still available.

With a pin, open some flowers of this group to learn the location of the important parts. These will include from the outside in, first, the green calyx of sepals which protect the bud; second, the corolla of colored petals which enclose the important organs inside and may attract insect visitors; third, the stamens which, in the mallows, are fastened together at their bases into a tube and bear at their free ends the anthers which produce the pollen; fourth, the pistils inside which have already been described.

If a bud or a flower which has just opened is examined, one may carefully cut the corolla away with a pin point leaving the pistils exposed for further development. If this is enclosed in a small paper bag while still on the plant, stray pollen can be kept away. Some time later, the pistils will have developed until they are spreading at their tips and are ready to receive pollen.

Then, pollen from a desired plant can be applied by transferring it with the finger tip or with a small brush. The flower should produce healthy seed pods just as would any flower which had developed naturally.

In the elementary grades, all that would be needed would be for the child to see that he can, by this procedure, help produce healthy fruit bodies or prevent such fruits from developing. Later, he may wish to learn what kind of plants would develop from the crossing which has been made. It would be well then to work with flowers which are colored and those which are white. Try as many combinations as possible, crossing white with white; colored with colored; pollen from color on a white pistil and pollen from white on the pistil of a colored flower.

Some interesting results will be forthcoming though most of these mallows are biennial plants and the results may be delayed a couple of years. It might be better to work with shorter-lived plants such as petunias or morning glories because the seeds will grow into plants which will bear flowers more quickly.

By following essentially the technique just suggested, plant breeders have been able to produce remarkable new plants which bear more and better fruits than the parent plants, in a longer or shorter time as the need arises, and on drier or moister soil if this is important. Some plants so produced are better able to resist drought, the attacks of fungi, and of insects. They may develop superior flavors, colors, size or texture. In short, if man were given time he might produce plants to fill almost every human plant-need at almost any place. Children in the elementary schools can and should easily be taught the essentials of this process. The geranium or the petunia in the window box, a pin and a few paper sacks are all that are needed aside from the willingness to try. It is worth the effort if it will help a few youngsters understand this important part of the story of life.

Steps in Reproductive Development

Most mammals have many glands which function throughout the independent life of the individual. The salivary glands which moisten the mouth and food are probably the best known of these. In mankind, the lachrymal glands, which supply tears, are able to function at almost any time. Some glands, however, such as the sex glands vary definitely in the intensity with which they function at different stages in the life of the individual.

From birth to puberty, in many men and in many other mammals, they are relatively inactive since they are held in check by the hormones of the pituitary gland, which stimulate growth, and by the secretions of the thymus.

In the female animal, the glands are the ovaries, a name which is significantly but loosely applied to the part of the pistil of a flower which bears the ovules which develop into the seeds. Signs of activity of these glands in a female mammal include the development of the breasts. In the male animal, the glands are the testes. The growth of hair on the face, chest and other parts of the body and the changing of the voice may be taken as evidence that these glands are beginning to assume a more dominant influence.

This development varies greatly in different races of human beings and in different species and in groups of species of animals. A field mouse may become sexually mature in a month; an elephant may require thirty years to reach a corresponding development. Norway rats mature at two months; house mice, at two and a half months; guinea pigs, at three months; sheep, pigs, and opossums, at one year, cattle, at a year and a half; monkeys and blue whales, at three years; camels, at five years; apes and men, around twelve years. From this, it may be seen that size is not always the determining factor since the seventy-seven-foot sexually mature blue whales mature long before the smaller camels, apes, and men. However, the smallest mammals, the shrews, probably mature early and possibly live their entire life span in less than three years.

It is common for the females to mature earlier than the males whether this concerns mice or men. Female meadow mice may give birth to their first litter of young at about the time the brothers of their litter become capable of reproducing their kind. This assures against interbreeding at the start with these animals. Obviously, there is little time for play and recreation in the life of an animal which may begin to produce a new generation within a month of the time it was born.

In human beings, one of the most important chapters in life is the period of adolescence which may run from the ages of twelve or fourteen to twenty-one or twenty-five. While many important adjustments are made in this period, they are not necessarily so spectacular or sudden as some would contend. An excellent discussion of this important period is contained in a booklet, *Adolescence* by M. A. Bigelow, published at low cost

by Funk and Wagnalls. Much that has been written about the developments which take place in the physiological and psychological make-up during adolescence is more spectacular than true. If the new problems which arise are reasonably well understood, they need rarely be serious for a normal person.

Puberty, or the time when a person is capable of reproducing his kind, normally comes between the ages of twelve and fifteen years.

In most male animals when this stage in development comes, some of the secondary sexual characters have appeared. Roosters have developed their wattles and begin to crow; fish, such as the horned dace, take on new colors and tubercles on their heads. Boys' chins become "pubescent" or covered with down and their voices may change. These obvious characteristics may be accompanied by nocturnal emissions popularly known as "wet dreams."

These are new experiences to boys and are identified with parts of their bodies which they have been trained to consider private. They are not unpleasant, except for the sanitary aspects with which they are associated, and are likely to be encouraged because of the satisfactions associated with them. They are perfectly normal and are not weakening unless they come too often. They are not periodic and may come reasonably frequently for some time and then at considerable intervals. Their greatest danger lies in the possibility that their novelty may invite investigation of experiences associated with them which may have dangerous aspects.

Boys should know that it is not necessary that the urge of these glands be satisfied artificially, or by intercourse, to assure normal healthy adult qualities. The situation is not comparable to the weakness that results from unused muscles since this is a gland problem and not a muscle one. The loss of self-respect, the danger of disease, the ills arising from fear of the unknown, and the violation of the principles of the Golden Rule may be some of the restraining influences which would control the activities of adolescent boys to the end that they may get the most of this part of human experience when they can assume the economic and biologic responsibilities which go with it.

Some humans are ruled only by fear. For these, the dangers of disease and of having to assume responsibility for their acts even at the distress of others should be understood. But decent young men should not be haunted by fears that the occurrence

of these nightly emissions are a sign of weakness any more than they should be distressed by the fact that they may have to add shaving to their morning routine. Normally, the situation will take care of itself if it is not magnified by fear or unduly encouraged by unwise associations. Youths actively engaged in preparing themselves to make a successful living in their chosen field should be too busy preparing to lead wholly successful lives to take on the responsibilities which arise from premature experiences in the sexual field.

The semen which is produced in these nocturnal emissions will be discharged whatever the individual may do to retain it. It is not wholly of the same materials as those which are secreted internally from the testicles during the truly sexual act and does not affect growth and body metabolism or produce the same bodily exhaustion. An excellent treatment of this phase of the whole problem is given in Dr. Harold S. Diehl's *Textbook of Healthful Living* published in 1939, by The McGraw-Hill Book Company. Boys should learn to recognize that encouragement of the sex impulse is dangerous since it can easily become master of an otherwise rational human being.

The problems which face girls during adolescence are as difficult as those which face young men. The appearance of menstruation, usually when the girl is between twelve and fourteen years old, may be taken as a sign that the girl is sexually mature. This is a normal process and should be recognized as such. Uninformed as to its nature, the girl may easily be frightened by the phenomenon. Some authorities say that about 85 per cent of the girls experience first menstruation without pain or discomfort.

Menstruation is due to the normal breaking down of the lining of the uterus which has developed to receive a fertilized egg. When no fertilized egg is present, the layer breaks down and is discharged. Appearance of the menstrual flow is, then, reasonable evidence that no fertilized egg is present.

Fertilization in mammals cannot take place unless sperms are present and, unless fertilization takes place, new individuals cannot begin development. This is not true of all organisms. In the dandelion, for example, the egg cell is never fertilized, and yet the new individuals develop without it. In some organisms like frogs, fertilization may be induced artificially by pricking the eggs, and other unusual methods have been discovered for

developing young without the procedures typical of that which takes place in the mammals.

The sperms of the males of many species of animals may be long-lived. Once they have access to an egg there is definite possibility that a new generation may be begun. In honey bees, the female mates but once in her life. In that one act, she gets enough sperms to last her a lifetime. Hens mated with a rooster may produce fertile eggs as a result of that mating for nearly a month. In fact, the highest chance of fertility with chickens comes with eggs laid some seven days after the mating. Hens have been known to lay fertile eggs twenty-eight days after a single mating. In bats, the mating act may take place in late summer or fall and yet the fertilization of the egg may not take place until the following spring, the sperms living in the female during the interim.

So it is with human beings and others. The sperms produced by the male do not die immediately if they are in suitable surroundings. They are able to swim of their own accord and they may fertilize an egg some time after they leave the male animals. As there is a time in the chicken when there is most likelihood that an egg will be fertilized after the sperms are introduced, so there are times with mammals when this is most likely to happen. As in the chicken, so in man there is no time in a month when this is impossible. For this reason, there is no really universally "safe period" when intercourse may be indulged in without the likelihood of starting a new generation and assuming the obligations associated with it. Simply because an experiment in this field may not result in a pregnancy does not indicate that the same result will arise from a repetition of the "experiment." Girls should know this for their own good and for the good of their children even though they may be of the type which does not have the protection which modesty and reserve normally provide.

As with men, so with girls, some individuals hold themselves in reserve only through fear. For these, the dangers of disease, loss of self-respect and of respect of others, and increased seriousness of economic difficulties may well provide a protection they would not otherwise have. All should recognize the dangers associated with behaviors which make the members of either sex forget in the satisfactions of the moment the responsibilities which are assumed. Petting, liquor, and compromising situations

which may lead to a weakening of natural inhibitions which serve as a protection, should be recognized for the dangers which accompany them.

Reproduction should not be thought of solely as something to be avoided. When conditions warrant, it is to be sought.

With most of the higher animals there are recognized different stages of development of the sexual urge associated with the reproductive act. Briefly these periods are spoken of as follows:

The *anoestrous* period in which the female is not inclined to mate.

The *proestrous* period or "heat" period in which, in some mammals, the vagina is swollen and may produce blood.

The *oestrous* period in which the female is receptive of the male and conception may well take place.

If conception takes place, it is followed by a period of pregnancy or gestation, extending to the time of birth; and in mammals a period of lactation in which milk is provided by the mother for her young. The lactation period may vary greatly in different mammals even though some may be closely related. In Stellers sea lion, lactation lasts for more than a year. Young walruses do not develop their tusks sufficiently to dig their own food of mussels for two years and so must be fed by the mothers. The manatee or sea cow nurses her young for eighteen months; the right whale, one year; the blue whale, seven months; the opossum, two months; fur seals, for from six to eight weeks at two or three day intervals; field mice, ten days, and so on.

Regardless of whether pregnancy takes place, there is in the normal cycle a period of *metoestrum*, or a return to normality in which fruitful mating does not normally take place.

A quiescent period follows which is normally followed by a repetition of the cycle.

With various animals this cycle usually is characteristic of middle life. With humans, the female may go through the cycle again and again between the time menstruation begins and the menopause, after which time the woman does not normally reproduce. This may cover the period between fourteen and fifty years or may be delayed until as late as sixty. During all this time, a woman normally would free for possible fertilization some 300 of the 30,000 to 50,000 eggs which her ovaries contain. Only one of these eggs is normally freed for fertilization at a time. Men, on the other hand, may free from 200,000,000 to 300,000,000 sperms in a single emission. While women normally

free but one egg a month, men may have a great many emissions in the same period of time. Obviously, in such a situation, failure rather than success is the lot of an overwhelming proportion of the reproductive cells produced.

In mammals, the breeding season is spoken of as the time of the year when reproduction may result from mating. In many mammals, there may be but one oestrous period for the female in a whole breeding season. This is probably true of foxes, bears, dogs, seals, bats, and wild pigs. These animals are said to be *monoestrous*.

In animals of the monoestrous type, it is highly important for the perpetuation of the species that when a female is in oestrous and receptive that a male be present and able and willing to cooperate. Otherwise, the female may have to wait for a whole year before she can possibly produce young. With some birds and mammals, the oestrous period may be for only a few days or hours. For this reason, animals whose numbers have been greatly reduced, from one cause or another, may become extinct even though considerable numbers of both sexes are still living.

Another type of breeding season is represented by those in which the female may have fruitful mating at a number of times during the breeding season. In this category, appear rabbits, most rodents such as tree squirrels, field mice and ground squirrels; domestic and wild cats; the domestic pig and a considerable number of other domestic animals. Animals with this type of breeding season are reasonably sure to produce a normal number of young each breeding season. If the animals are polygamous, as are the domestic cats and most other domestic mammals, the offspring of many a litter may have different fathers.

With many species of animals, while the female may have limited periods in which fruitful mating may take place, the males may be capable of producing fertile sperms at any time even though they may be stimulated to do this by the female more at some times than at others. Males of domestic dogs, monkeys, horses, bulls, humans, and of most domestic animals may be induced to breed at any time of the year. In deer and most carnivorous animals, this period for males is limited to several weeks in a year, the season of rut. In wild mice, the period is roughly a half-year. While wild elk have the period limited to a few weeks in the fall, captive elk may breed at any time of year except when the horns are gone.

The quiescent period which follows the breeding period in animals varies greatly in length. With field mice, it may be for only a half-hour after the previous litter has been born. With seals, a new generation may be begun within a few hours after the single pup is born. With the Norway rat, this period may be four days; with the house mouse, four to six days; with the deer mouse, five days; and with the cotton rat, from five to nine days.

Comparatively little is known about these important stages of the reproductive cycle in most common living things. Man differs from other animals in degree of imagination and in ability to solve problems intelligently. He should be able to plan his life wisely through the years which are given to him. An understanding of the problems of reproduction as they apply to man himself and to the animals with which he must share his life should lead to greater happiness and comfort for all concerned.

It does not seem reasonable that populations should be increased in thickly settled parts of the earth, where the result may be war and the crowding out of other populations. Neither does it seem reasonable that encouragement should be given to the production of large families where, through disease or inability to meet the demands of civilization, there would be an unduly increased burden on those unable to enjoy fully the fruits of their own labors.

With intelligence and kindly consideration for the rights of all concerned, policies can be worked out whereby the knowledge now available to mankind, coupled with his idealism and common sense, may make life on the earth for man and his associated animals a progressively happy experience for all. Any other outlook on life may be due either to ignorance, unjustified selfishness, or unwarranted morbid fatalism. The school has it in its power to help develop this outlook along rational lines.

MELTING POT

The Oswego (N. Y.) board of education asked the Army to permit some 175 refugee children, stationed at Fort Ontario, to attend its public schools. The children arrived in the United States in July with a group of 1,000 European refugees who entered the country with Presidential permission and under Army guard. Original plans was to keep the Europeans, representing 18 nationalities, "behind wire." Their great concern for the childrens' schooling and the apparently high intelligence among the children, prompted the board of education's action. Government officials consented to the plan.

PRINCIPLES OF SOLID GEOMETRY BASIC TO NAVIGATION

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During the life of Christopher Columbus and for a time thereafter, but for slow communication of ideas, the world would have become more universally conscious of some of the concepts of solid geometry than ever before in history. The great discoverer transformed the disc world of earlier days into a cylindrical world. In 1569, a Flemish cartographer, one Gerhard Krämer, designed the so-called "Mercator" map projection for use by "merchants" and traders, navigating the oceans. He visualized externally, for many men, a cylindrical earth.

People continued to speak of the earth as spherical, but pictured it on charts and maps and visualized it, in navigation, in matters of international travel and trade, in diplomacy, in study of international and national defense—always as cylindrical. The north and south polar regions, because of climate, were barriers, of such proportions to navigation and international relations that it mattered, not at all, that there was no provision for them on the Mercator plan of projection, or if a point near such a latitude was represented, necessarily by the circumference of a circle the size of the equator. Suppose Greenland was shown misshapen and nine times its area, few men were ever interested in going there, or in knowing whether the land is green or covered with "icy mountains." If they wished to go there, the adventurous could find it eventually. In a lifetime of exploration, a few months, more or less, would not matter.

Then men began to fly. The First World War set off world wide impetus to flying. Remarkable development of aircraft, operated at surprising speeds and heights, over water, as well as land, followed. Charles Lindbergh flew the north Atlantic, but not along the old maritime routes. Polar expeditions became world news. *North to the Orient* and later, *Listen! The Wind* were read, not by aviators and geometry students, only, but by all high school youths. As a guide to aerial navigation the Mercator projection was outmoded. The projection known technically as the "Lambert conformal conic," for the average man, who never steered a sea going ship by magnetic compass or sextant, seemed to represent larger portions of our earth more accurately.

When one traveled on the great, fast, ocean liners, during certain months of the year, the "northern route" was used. Moreover, why "north" to the orient? Men had always sailed from San Francisco directly west to the orient. Somehow our atlases did not satisfy our inquiring minds. Even the newer library editions failed us. Navigators must be visualizing our earth and its routes differently. Were they alone seeing the earth pictured in this new and unusual manner? How were our diplomats, our leaders in international affairs visualizing world routes?

Then the Second World War opened. At once, the average man realized that it is important to know how the enemy is viewing the world. Then it was said that planes had been developed to fly 400 miles an hour. Black-outs, dim-outs and other air raid protection caused folk to become interested in new maps, shortest courses, and the radius of action of a bomber or fighter plane. It soon was well named, sociologically and psychologically, a "global" war. Maps and charts now appear in magazines and daily papers. All who read are concerned. Such maps become topics of conversation on public conveyances. One's distance from the coast is discussed in this connection on the street car any morning. What is meant by "one's distance from the coast"? Ours are two long coast lines.

Among students and teachers of mathematics, the important question is raised as to what parts of our solid geometry are pertinent, even necessary, to a fundamental understanding of the science of navigation. First, we must consider the imaginary axis, upon which the earth, an oblate spheroid, turns. Then, for the geographic lines of reference, the plane of the equator, a great circle, is perpendicular to the axis. For measuring longitude east and west of Greenwich, the meridians, for navigational purposes, great circles, contain the axis as their common diameter. Then, there are for measuring latitude north and south of the equator, the parallels, intersections of the earth's surface made by planes parallel to that of the equator. The parallels are intersected by all of the meridians perpendicularly. Outside the earth is what is called astronomically the celestial sphere, Polaris approximately over our north pole, the other stars and planets regarded as projected on this larger concentric sphere, the celestial equator, the intersection of the extended plane of the earth's geographic equator with the celestial sphere.

We must use the system of circular measurement, with its 360°, 15° of which, in longitude, account for one hour in our

sequence of 24 time "lunes" misnamed "zones" or "belts." However each is not an exact geometrical lune, but only approximately so, as its boundaries are a result of legislation.

Now to transfer any portion of the almost spherical earth's surface, overlaid by such a grid of geometrical lines of reference, to a flat map, or to represent even a small portion of a sphere on a plane, that is the problem of the world's cartographers, of all time. Only an accurate globe represents the earth correctly. No portion of a sphere, however small, can be spread out flat without some stretching, tearing, and hence distortion.

Thinking in terms of the figures of solid geometry, the cylindrical surface can be cut along an element, and flattened, to produce a plane rectangular surface. Moreover the conic surface can be cut similarly from base to apex, and spread out flat in a circular sector.

To acquire an understanding of the Mercator projection, which is actually arrived at by most intricate computation, mathematically, let us imagine a circular cylinder enveloping the globe, tangent to it, along the equator. Let us think of the eye of the observer as at the center of the sphere. Then let him see the meridians and parallels projected before him onto the cylinder. The meridians will appear as parallel, vertical, straight lines, equally spaced. The equator and parallels will be depicted as straight and parallel to each other and perpendicular to the meridians, but unequally spaced, further and further apart as they are located further away from the equator. At the equator, areas, directions, shapes and sizes will be accurately represented. Further from the equator, areas will become too large and elongated as they are located nearer the poles. Therefore no common scale can be used for the map. On all parts of the projection, parallels and meridians meet as they do on the globe, at right angles. This is the chief merit of the projection. It enables a rhumb line to be represented as a straight line. A rhumb line is one that crosses all meridians at the same angle. Thus a navigator of a ship, after drawing a straight line joining his point of departure with his point of destination on such a map, may measure the angle of this line with a meridian and steer his course for hours or a day, at a time, with unchanging magnetic compass. However a rhumb line does not represent the shortest distance between two points on a globe. Only the minor arc of a great circle joining the two points is the shortest distance. If one line is drawn on a Mercator projection, a con-

tinuance of minor arcs of great circles, from meridian to meridian, at constant angle with the meridians it will spiral toward one of the poles.

If somewhow, one could pull together, to a single point, with a gathering string, geometrically, the upper edge of the Mercator map, and yet keep it flat, the cartographer's problem would be solved.

Why not try to use a circular cone? Let it be tangent along one of the parallels, with the apex above the north pole. The meridians would project on the cone as straight converging lines; the parallels, arcs of concentric circles. One would have forfeited the accuracy of angle between parallel and meridian. Areas along the circle of tangency would be correctly represented. In higher latitudes there would be distortion in shape, and areas would be enlarged. Neither great circle courses nor rhumb lines would be straight.

The United States Coast and Geodetic Survey devised a polyconic projection plan, a series of such enveloping cones, tangent along a series of parallels, using just a narrow strip longitudinally of each conic surface. When these strips were flattened and fitted together, there was inaccuracy due to wedges or gores necessarily introduced laterally to accomplish the flattening, but no part of the original plan of projection. However, if a long central strip, only, of great extent in latitude, of such a projection is used, the result is a satisfactory chart. Parallels would be represented as curves, but not concentric arcs. Meridians would be curved and converging. Neither a great circle nor a rhumb line would be a straight line. Areas would be well represented in size and shape. This type of projection would be best to depict the state of California, Florida or Scandinavia, for example.

On the contrary, to chart regions of extensive longitude the Lambert conformal conic projection is used. Its plan is that of a cone intersecting the globe along two standard parallels, protruding outside above and below these two parallels, but cutting through the sphere between the parallels. Above and below the standard parallels the globe is projected outward; between, inward. For aeronautical charts of the United States the standard parallels are 33°N. and 45°N. Along the circles of intersection, the representation is accurate. Between, above and below, the error is small. The meridians are represented as converging straight lines, the parallels as concentric circles. The meridians do not intersect the parallels perpendicularly. A rhumb line

on a Lambert projection is not a straight line. A great circle on a chart of a small area is approximately straight. Areas are well represented as to shape and size. Distances can be scaled with very little error.

The gnomonic projection is the development of aerial navigation. Again, imagine the eye at the center of a transparent globe. A plane is tangent at the north pole. The meridians will be projected on this plane as straight lines radial from the pole; the parallels, concentric circles with the pole their center. Obviously, the meridians will not meet the parallels at right angles. Areas and shapes will be correctly represented only quite near the pole. On the periphery there is distortion of shape and great error in size. Distance can not be scaled. Any great circle on the globe will be projected as a straight line, in that the center of the sphere and any two other points, not all on a straight line, determine a plane. Such a plane cuts the sphere in a great circle, and cuts the tangent plane in a straight line, the projection of the great circle intersection. Conversely, any straight line on the tangent plane represents a great circle since it with the center of the globe determines a plane. This latter plane cuts the globe in a great circle. Therefore the straight line on the plane of projection is the shortest distance connecting the two points under consideration on the globe. The circum-polar gnomonic map is important in that so much of the land of our earth is located about the geographic north pole. The Arctic Ocean is actually a mediterranean ocean. On the contrary, the south circum-polar map shows, in the main, ocean.

The plane of the gnomonic projection may be tangent at any point on the surface of the globe. In that case, in that the equator is, and the meridians may be assumed to be great circles, they will project in straight lines. The gnomonic chart is of little value excepting for finding great circle courses. In use, the course will be transferred point by point, by using the latitude and longitude reading of each point, to a Lambert chart or other type appropriate for scaling distance and measuring angular direction.

Of mathematical interest too are stereographic, orthographic, and azimuthal projections.

All projections of the earth's surface on planes are inaccurate. Each type has merit. The student of navigation should be well grounded in the values and shortcomings of the different sorts, so as to judge wisely as to his selection of map or chart for his

particular purpose, at any moment. The smaller the portion of the globe being represented, the less the inaccuracy with which to cope. The actual scientific construction of maps is the problem of cartography. Navigators learn to intelligently interpret, select and use those already available.

Fundamental too to the science of navigation is the correct concept of a spherical angle, that of the plane angle formed by two straight lines, one tangent to each great circle arc of the spherical angle at their point of intersection, or vertex of the spherical angle.

RADIO IN THE WAR

Extracts from an Address by LIEUT GEN. JAMES G. HARBORD

For the use of our armed services, RCA has developed more than 15 new electron tubes and approximately 300 types of apparatus not manufactured by anyone before the war. A vast amount of new knowledge about short waves is being gained. Research and an opportunity for field testing, which would ordinarily require years, have been compressed into months. The demand on the radio industry for millions of electron tubes of all sizes, great numbers of transmitters, receivers, antennas and other essential equipment can be realized only when we think of the size of our 7,000,000-man Army and two-ocean Navy. They are fighting what almost might be called a 'radio war,' because the science of radio-electronics is playing such a conspicuous part for victory.

RCA's production of radio, electronic, and sound equipment for the armed forces of the United States and of the United Nations increased nearly 100 per cent in 1943 over 1942. In 1943, production amounted to $222,000,000. On July 1, 1944, unfilled orders totalled $300,000,000. RCA personnel now numbers more than 42,000, of which 48 per cent are men and 52 per cent are women. More than 7,000 RCA employees have joined the armed forces, and 49 have given their lives.

AWARDS FOR RESEARCH

Pi Lambda Theta announces two awards of $400 each, to be granted on or before August 15, 1945, for significant research studies in education.

An unpublished study on any aspect of the professional problems of women may be submitted. No study granted on award shall become the property of Pi Lambda Theta, nor shall Pi Lambda Theta in any way restrict the subsequent publication of a study for which an award is granted, except that Pi Lambda Theta shall have the privilege of inserting an introductory statement in the printed form of any study for which an award is made.

A study may be submitted by any individual, whether or not engaged at present in educational work, or by any chapter or group of members of Pl Lambda Theta.

Three copies of the final report of the completed research study shall be submitted to the Committee on Studies and Awards by *July 1, 1945.* Information concerning the awards and the form in which the final report shall be prepared will be furnished upon request. All inquiries should be addressed to the chairman of the Committee on Studies and Awards.

THE GREATEST FREQUENCY OF A COMPOUND PENDULUM*

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The frequencies of sound, of quartz crystals and electrical systems are very much the vogue these days. New concepts often prompt one to go back and look at old concepts. One of these old concepts is the simple pendulum and its relation to the vibration of any physical object, that is, the compound pendulum.

The general equation for a compound pendulum is

$$T=2\pi\sqrt{\frac{I}{mgh}}=2\pi\sqrt{\frac{\sum md^2}{mgh}}=C\sqrt{L}$$

$I=\sum md^2=$ moment of inertia about any given axis
$h=$ distance from center of gravity to that axis
$C=$ a constant
$L=$ length of equivalent simple pendulum

Out of this fundamental equation, an expression for L involving h and k, the radius of gyration about any given axis is straightforwardly obtained.

$$I=md^2=I_p+mh^2=mk^2+mh^2$$

$$T=\frac{2\pi}{g}\sqrt{\frac{mk^2+mh^2}{mh}}=C\sqrt{\frac{h^2+k^2}{h}}=C\sqrt{L}$$

$$\therefore\quad L=\frac{h^2+k^2}{h}=h+\frac{k^2}{h}$$

This equation nicely illustrates the fact that if h is zero, L becomes infinite and the frequency is also zero. The object does not swing as a pendulum when supported at its center of gravity.

In this field of sheer mechanical vibration it becomes particularly relevant to revive a concept which is not new* but is nevertheless worth while to re-examine these days when so much effort is being expended to get higher and higher electrical frequencies. The concept and the question is, about what point can a compound pendulum be swung in order to present its

* See Ziwet and Fields, *Mechanics* page 308, 1912; Champion and Davy, *Properties of Matter*, 1936; Newman and Searle, *General Properties of Matter*, 1933; Millikan, Roller, Watson, *Mechanics, Molecular Physics, Heat and Sound*, 1937

minimum equivalent length? In other words, about what point will a compound pendulum oscillate with its maximum frequency?

The answer is nicely arrived at by a simple use of the method of maxima and minima of calculus. This problem offers a practical and illustrative example of one of the basic concepts of the calculus.

The case in point is: Changing h makes a change in L; what value of h gives a minimum L? As per simple calculus, take the derivation of L with respect to h and equate to 0.

$$\frac{dL}{dh}=\frac{d}{dh}\left(h+\frac{k^2}{h}\right)=0$$

$$=1-\frac{k^2}{h^2}=0.$$

$$\therefore\ h=k.$$

$$\therefore\ \text{When } h=k \qquad L \text{ will be a minimum.}$$

So if a compound pendulum is swung about an axis at a distance of k above the center of gravity P as its value of h, then the compound pendulum will be swinging with the shortest equivalent ideal length and in turn will have its shortest period and greatest frequency.

Having obtained this value of h as k resulting in greatest frequency, one can now find the equivalent ideal length for this condition:

$$L=h+\frac{k^2}{h}\cdot \qquad \text{If } h=k.$$

$$L=2k=\text{minimum value.}$$

$$\therefore\ L_{\min}=\text{twice the radius of gyration about } P.$$

The answer originally sought turns out rather surprisingly to be a simple relation between L and k.

The length of the shortest equivalent ideal pendulum which enables a compound pendulum to swing with its greatest frequency is $2k$ and the compound pendulum must be rotated at a point k above its center of gravity.

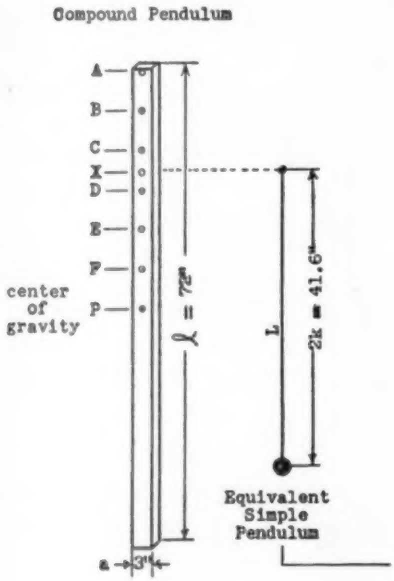
Experimental Demonstration

To get an idea as to practical and experimental verification, consider the case of a rectangular sheet—a bed slat, as it were.

For such a compound pendulum, the moment of inertia about an axis at center of gravity perpendicular to the sheet,

$$I=mk^2=m\,\frac{a^2+l^2}{12}\cdot$$

For various points vertically above P, L can be readily calculated. As an illustrative and confirming laboratory or demonstration experiment, holes could be bored in the slat and the elapsed time for 25 vibrations found by a stop watch or an electric clock. See Fig. 1.



$$I=mk^2=m\,\frac{a^2+l^2}{12}$$

$$k^2=\frac{9+5184}{12}=432.75$$

$$k=20.8$$

$$L=h+\frac{k^2}{h}$$

when $h=k$

$L=\text{Min. Value}=2k=.577l$

FIG. 1

Point of Suspension	h		L	
A	36.0"	1/2 l	48.0"	.66
B	30.0	5/12	44.4	.62
C	24.0	1/3	42.0	.58
X	20.8	1/3.466	41.6	.577
D	18.0	1/4	42.0	.58
E	12.0	1/6	48.1	.66
F	6.0	1/12	78.1	1.08
P	0.0			

GRAPHICAL ILLUSTRATION

Since

$$L=h+\frac{k^2}{h},$$

$$h(L-h)=k^2=\text{a constant.}$$

This is the equation of an hyperbola.

When h and l are plotted, the graph of Fig. 2 provides interesting observations.

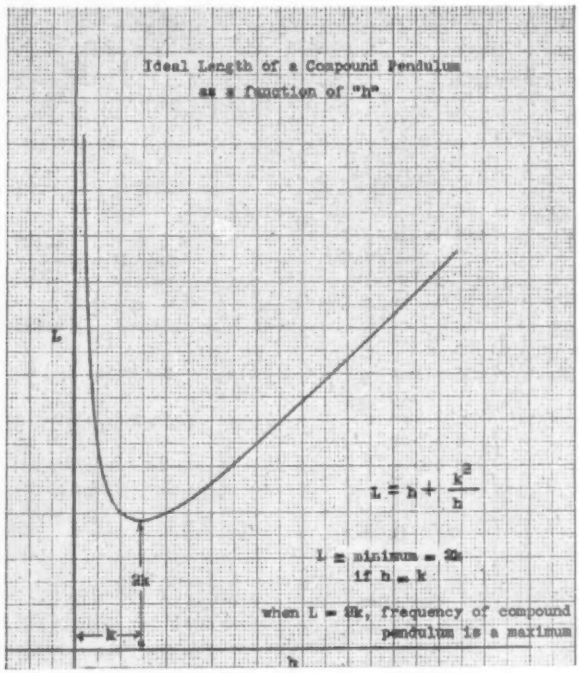


FIG. 2

NEW GEOLOGIC MAP OF THE UNITED STATES

A new map of the United States, depicting the complete geologic structure of the nation, is now finished and will be available soon. The four-by-six-foot map, in seven colors each indicating geological features, is the first of its kind ever to be published.

This map, technically a tectonic map, was prepared after nine years of work by a committee of 16 experts headed by Dr. Chester R. Longwell, professor of geology at Yale University. The committee is a division of the National Research Council. The other members were well known, widely distributed geologists from universities, the government, and from petroleum and other industries. It will be obtainable from the American Association of Petroleum Geologists, Tulsa, Okla.

The map will be of particular value to research geologists, petroleum geologists and engineers, and to college instructors in geological fields. It gives an over-all picture of the major structural features of bedrock, with a consequent direct relationship to the occurrence of petroleum, and will directly aid research students working on the cause of large scale movements of the earth's crust.

CHANGES AND ANALYSIS OF THE CHANGES IN THE SUBJECT MATTER AND METHOD OF TEACHING SCIENCE IN SCHOOL "A"

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I. INTRODUCTION AND DEFINITION OF ELEMENTARY SCIENCE

By Elementary Science we mean work in an area dealing with natural or physical phenomena.

In the process of writing this short paper, we shall try to find out what has been taught as science in School "A," what is now being taught, and what are the practical relationships of these to the people that the school serves. School "A" is an actual school in New York State.

Before writing this report, the materials listed in the bibliography were not only consulted, but actual situations in science work were observed, and contact was made with teachers who had and were teaching this kind of work.

II. STARTING IN 1920

In 1920, the science work followed the State Course of study in both method content, and in regard to minimum essentials. According to this, all of the important information units are divided up into groups under different topics. Then, each topic is noted according to difficulty in teaching that particular thing. Then the easiest eighth of the work is given to the first grade, and other eighths according to their difficulty to the other seven grades. The work for each grade was then divided in halves for each half year. The work for each half year was then divided into sixteen parts, one part for each week in school.

In elementary School "A" at that time, science not included in the State Syllabus was not considered in the school program. If a pressing problem in health or science occurred in the community, very much attention could not be given it, because it was necessary to cover the work outlined for that week. Even at this, a great amount of time was not spent on science, because many teachers were not prepared and felt other more traditional subjects were more important in the grades.

III. STATE DIRECTED

In examining the Syllabus in Hygiene, we find it set up in the manner previously described.

A list of devices or tricks for teaching Habits and Information which constituted the work was set up. The following is an example of a story that is read to children to teach them good habits.

A Good American

"Billy Jones is a little boy 6 years old. He is in the first grade at school. Billy wants to learn to read and write. His teacher says, 'Of course, Billy, we are going to learn to read and write but first of all I want to tell you what we must do to be good Americans.'

" 'To be good Americans we must be well and strong. If you are sick you cannot go to school, you cannot help mother, you cannot shovel snow, you cannot be a soldier; you couldn't even wave a flag if there was a parade. To be well and strong little boys and girls must sleep at least 12 hours every night.'

"Billy Jones wants to be a good American more than anything else. So every night Billy listens to the clock. It strikes seven and Billy says, 'All right, mother, I am going to bed.'

"He goes upstairs, takes off his suit, mother helps him with his bath, gives him a drink of cold water and he gets into bed. Billy snuggles under the warm, light covers as mother opens the window to let in the fresh air and says, 'Good night, Billy Boy.'

"The next time Billy hears the clock it strikes seven again and mother is calling, 'Come, Billy, time to get up!' Billy stretches his arms and legs, then gets up and dresses. He knows that every good American boy is up and dressed before 8 o'clock."

After having this story read to them first grade children are not supposed to give their parents any more trouble in going to bed at night or getting up in the morning.

Later in the book, we are told how to have a health club originate with the children. I will describe the steps listed:

1. The teacher addresses the class on health.
2. The teacher suggests organizing a club.
3. The teacher outlines the honor roll idea.
4. The teacher asks the class to vote on this plan. (According to the book, they always vote in the affirmative.)
5. The teacher asks the class to vote on inspectors.
6. The teacher directs the inspectors.
7. The teacher supervises the entire program.

8–12. etc.

By briefly looking at this, we see just how much of the so-called health work is done by the teacher and the pupil.

The report card on health education lists as its objective, "To make health habits automatic through education, thereby adding years to the lives of the coming generation" then each child was marked on the following: clean clothing, clean face, hands, nails, teeth, neatness of desk, books, floors; and posture sitting,

walking, standing. No mention was made of the child's actual condition of health, his actual living habits, sleep habits or diet; with the exception of memorizing the things that were good for him.

In the *Tentative Syllabus in General Biology* for 1931, we find that science in the junior high school should consist of: study of environment, the pupil should be led to investigate, should explore all fields which are important to him, etc., in order to prepare students for biology in the tenth year that can have a more detached point of view.

By looking at this *Syllabus* that came out a year later, we see that elementary science is taught so that we can teach advanced abstract science. However, we also notice another change and that is the reference that elementary science should be practical.

The *Syllabus for Elementary School Science* in 1931 in the introduction lists the following things to be developed by the content: sound scientific background, scientific method upon which health practices, public health responsibilities, civic practices and interpretations of geography may be built.

The major objectives are as follows:

1. To capitalize the child's natural curiosity concerning the scientific phenomena about him.
2. To teach pupils to observe the natural forms and the cause and effect of the changes in nature which are related to their daily life needs.
3. To develop in pupils a spirit of inquiry and to encourage a scientific attitude in order that they may become aware of the value of verifiable knowledge apart from mere opinion or authority.
4. To develop an appreciation of nature by calling attention to the beauty of color, form, functions, relationships and adaptions occurring in their natural environment.
5. To develop such elementary knowledge of scientific facts and principles as may be applied to health, social and civic habits.
6. To develop the ideal of kindness and justice toward animals as a primary step to a better recognition of kindness and justice toward one's fellows.
7. To develop wholseome interests that will guide the child's use of his leisure time.

Unlike the earlier objectives, these are more concerned with

what the child is and will be, rather than the amount of material he has covered and memorized.

Instead of it being suggested that every child in every school in the State during the third week in October study the same thing, the content, after it is divided up for the different grades according to difficulty, is then divided up into the seasons so that a teacher may take up certain kinds of work, according to the season that it is listed under.

We see, then, a tendency for the work to be presented so that it becomes more meaningful to the student.

The elementary school science syllabus for 1932 is practically a reprint of that for 1931 and offers no changes. I might add that both of these consist of a foreword, introduction, diagram of the content object and what part of this is taught in each grade; the objectives, procedures and activities for each grade according to seasons of the year; bibliography and list of publishers.

In this same booklet, we find mention that a program of natural science should be taught in connection with a life science laboratory consisting of ground area for gardens and a pen for animals.

During the year 1934, another edition of *Cardinal Objectives in Elementary Education* came out. This, of course, includes the work in science. This book elaborates upon a group of trends which are briefly as follows:

1. Increase opportunity for social experience among children.
2. Increase emphasis upon economic and social understanding.
3. Determining the place of drill in the activity program.
4. Selection of content around problems of learning.
5. The development of research attitudes and techniques.
6. Provisions for the development of individual aptitudes and interests.
7. The growth of an analytical and critical attitude among teachers.

All in all then, we find a steady chain of changes and improvements, for the most part, in the state courses of study. It is also a fact that these changes are in no way keeping abreast with the changes in our present day civilization.

About 1932, leaders in the State began to see that the all important thing was not how many beans usually in a pod and the names of all the counties in the State, but that other things were of equal importance. This can be proven by quoting from the *Cardinal Objectives in Elementary Education* 1932.

"During the past few years the State of New York has witnessed a gradual transformation in many of its elementary schools. There is abundant evidence not only that communities are building new school houses and repairing the old, but that they are encouraging a much more fruitful type of classroom procedure." This report deals primarily with the latter phase—with what is happening to children.

For some time school superintendents have believed that the fundamental facts in the elementary school curriculum have been fairly well taught. By the time a child, with even less than average intelligence, reaches the age of 12 years, he is able to manipulate figures sufficiently to make change, to read a road map, to write a check, to identify Washington and Lincoln, to read the daily paper and to do many other simple acts of nature. Such accomplishments, of course, are fundamental. Most children acquire them comparatively easily. Many men equipped with this limited training have accumulated wealth and have risen to places of power and responsibility. These essentials for the most part are fixed facts; they are always the same; five times three is always 15; Washington is always the Father of his Country; there is no choice or discrimination in the matter.

On the other hand, the better schools of today are concerned not alone with facts but with an enormous number of reactions which people make to varying situations. These situations are as changeable as the weather and capable of as many interpretations as there are individuals to experience them. We cannot foretell what a driver of an automobile will do if he suddenly sees before him a possible catastrophe, how a person will react to a Whistler etching, how another will get on with his neighbors, how another will take defeat, whether another will vote intelligently, or whether another will pursue his aim until he reaches it. Doctor Kilpatrick has well said that much time in the elementary school should be devoted to training children to meet the "unpredictable." Many qualities which are grouped under such words as personality, character, common sense, adaptability, etc., seem to be indispensable to a significant life. As yet the elementary school has concerned itself more with facts than with personality; more with skills than with character.

IV. School "A" Develops its Own Course of Study!

Because the materials and procedures outlined in the state course of study was not keeping up with the development of our

civilization and meeting the needs of the children of School "A," a new plan was necessary.

In 1927, the supervisors and teachers of School "A" set out to develop a plan of work in the elementary schools that would fill these needs. Problems that were in the field of either the natural or physical sciences were discussed to see what bearing they had upon the life of the children or adults of this community.

These problems or experiences were taken up by a teacher with her group, if she thought her group would be interested or benefited by them. As the teacher brought in problems, the children also brought in problems and experiences to share with one another, thereby making a very valuable contribution. As this work was developing, the various state bulletins were used as references.

By 1934, a great amount of attention was being given to problems and interests of individuals, groups, and the school. Because each school is unique in itself, units of work cannot be set up for all schools, but must be developed by the individuals within the school.

The areas of work taken up were those that came out of the daily questions of children. Science was not necessarily taught just as science, but was taken up in connection with social studies and other phases of the program.

V. At the Present Time

Science is now included for the same reasons that other school subjects are included in the school program. Quoting from School "A's" objectives:

"We understand that the gaining of knowledge and skill is only a part of the work of the school. We realize how little the child's knowledge benefits him unless it has fitted him to take a worthy place in the community in which he finds himself, unless it enables him to be a respected and self-respecting member of his community.

"We realize, too, that the social problems of chilhood are as pressing as those of adult life. Children have social difficulties. Sometimes they cause grave emotional disturbance to the individual concerned; sometimes they constitute school and community problems. The child is a misfit unless even in childhood, he is a respected and self-respecting member of his group.

"And so today we are as much concerned about the habits and attitudes of the children as we are about their progress in

gaining knowledge and skill. The following seem to be the objectives of any school which aims toward a well-rounded development of its pupils:

"1. The school must promote good social and moral habits.
2. It must give an understanding of the world in which we live.
3. It must foster the development of good mental habits.
4. It must prepare the child to make wise use of leisure time and those of vocation.
5. It must give the child control of the tools of communication and computation.
6. It must help to establish good health habits.
7. It must foster conditions which give joy and happiness."

At the present time, the science work is not taught as an organized program of instruction, but the work grows out of the daily life of the individual.

The latest state *Syllabus for Elementary School Science* came out in 1939. Instead of demanding the study of certain areas for certain grades, this new Syllabus lists six content areas:

"1. There are many kinds of living things on the earth.
2. Earth conditions are changing.
3. Matter and energy are subject to many changes.
4. The earth is a small part of the universe.
5. Plants and animals survive many changes.
6. Living things are inter-dependent."

And a suggestion of how these can be taught on any grade level is given.

Each area in the *Syllabus* has listed problems, activities, and possible outcomes. This book has a noticeable improvement over all others and that is, it contains numerous scientific experiments that add value and interest to the work.

The new state *Syllabus* will make a good reference book along with many others in this field.

If, in the future, School "A" makes use of all these materials available and continues the program that they have started of building the science work around the school children and community, science will contribute a lot to the public school education.

An example of typical work can be cited in a fourth grade where the class as a whole became interested in electricity. All the members of the class looked up and wrote something con-

nected with the subject of electricity. Then members who were interested in certain phases made steam turbines, set up door bell sets, gave demonstrations to the rest of the class, and attended simplified lectures on electric meters and magnets given by the shop teacher. Some members of the class also brought in electric articles to the shop to work on, and although the main study of electricity is over, and the class has gone onto something else, certain individuals still carry on with their individual interests developed through this study.

This type of work may, or may not, be done in connection with other teachers and subjects, depending upon the case.

NEW ERA OF EXPANSION IN RADIO INDUSTRY

Television, radar, and other wartime developments in radio-electronics have brought the American radio industry to the threshold of another great era of expansion—greater even than the achievements of the last quarter of a century, Lieut. Gen. James G. Harbord, Chairman of the Board, Radio Corporation of America, said in a statement commemorating the observance of RCA's twenty-fifth anniversary.

"Today, the radio-electronic products of our laboratories and manufacturing plants are providing the Army, Navy, and Air Corps with some of the most essential means for winning this global war," General Harbord said. "When Victory is ours, the fruits of these scientific and engineering accomplishments will be turned into the channels of business and commerce. Ahead, lies the new Age of Television and other electronic marvels, which may be expected to have a profound influence on the habits and customs of people everywhere."

Calling attention to the fact that RCA was created in 1919, at the suggestion of officials of the United States Navy, to give America a system of international radiotelegraph communication independent of foreign interests, General Harbord said that the most sanguine hopes of 25 years ago had been far surpassed.

"Due to the far-sighted thinking of our leaders at the end of World War I," he declared, "the United States is today preeminent in world communications. The basis for the amazing expansion of American radio's uses in the Second World War began to be laid very soon after the Armistice of 1918. The First World War had proved what could be accomplished by directed research. The years between the wars developed radio communication and electronics to a point which changed the daily life of the nation.

"No more striking demonstration of radio efficiency and versatility could be imagined than the uses to which it now is being put on our fighting fronts and all the embattled seven seas," General Harbord continued. "Much of the story cannot yet be told, for reasons of Military security. One of the greatest chapters will relate the decisive victory over the U-boats by scientists of RCA and other laboratories, who are given primary credit for this great stroke for victory."

PANDIAGONAL MAGIC SQUARES AND THEIR RELATIVES

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The objective of this article is to bring out the relation between the natural order square and a group of related magic squares by transforming them into each other, using the 5×5 square as an illustration.

About three quarters of a century ago Rev. A. H. Frost was a missionary in Nasik, India. He was a fine mathematician and developed a group of magic squares and cubes that he called Nasik. He carried his investigations into hyperspace. There is, at least there was fifty years ago, in the South Kensington Museum (London) a model of a Nasik $7\times7\times7\times7$, constructed by him. He was the first to call attention to summation along other paths than rows, columns and diagonals. No other writer seems to have given this matter attention. This is unfortunate. It will be used in this article.

It is helpful to look at squares as a pattern that repeats itself in all directions on a checkerboard expanse. Figure 1 gives a natural order 5×5 square as part of such an expanse.

FIG. 1

1	2	3	4	5	1	2	3	4	5
6	7	8	9	10	6	7	8	9	10
11	12	13	14	15	11	12	13	14	15
16	17	18	19	20	16	17	18	19	20
21	22	23	24	25	21	22	23	24	25

FIG. 2

1	7	13	19	25	sum 65
2	8	14	20	21	sum 65
3	9	15	16	22	sum 65
4	10	11	17	23	sum 65
5	6	12	18	24	sum 65

Figure 2 gives one set of diagonals with their summations. The first is the main diagonal. All the others are ***broken*** diagonals, i.e. they are broken by the side of the square. They may be thought of as continuing on into the next square, or as going back to the opposite side of the main square. We shall do well to train ourselves to follow all broken paths with only the main square before us.

Note the constancy of the summation, 65. In fact if you start with any number in figure 1, and take five consecutive numbers along any diagonal, the sum is 65. This constancy of summation is characteristic of all natural order squares, no matter whether the base is odd or even, prime or composite. In an $N\times N$ square the sum is $N(N^2+1)/2$

The summation along the rows of our 5×5 square is 15, 40, 65, 90, 115. The common difference is 25, the square of 5. The summation along the columns is 55, 60, 65, 70, 75. The common difference is 5. The like holds for all natural order squares. If the square is on an odd base the sum of the middle row and of the middle column is the same as that along the diagonals.

We come now to paths that are not rows, columns, or diagonals. We shall call them crooked paths. We get them by following the knight's move in chess or some modification of the knight's move. Figure 3 gives a set of such paths using the move two cells to the right and one cell down. Notice the constancy of the summation, 65. In fact you may start with any number in figure 1 and follow the knight's move consistently in any direction until you get five consecutive numbers; their sum will be 65.

FIG. 3

1	8	15	17	24	sum 65
2	9	11	18	25	sum 65
3	10	12	19	21	sum 65
4	6	13	20	22	sum 65
5	7	14	16	23	sum 65

FIG. 4

1	9	12	20	23	sum 65
2	10	13	16	24	sum 65
3	6	14	17	25	sum 65
4	7	15	18	21	sum 65
5	8	11	19	22	sum 65

Figure 4 gives a set of paths for which we have used an elongated knight's move, three cells to the right and one cell down. All that we noted about the knight's move paths holds true here also.

Constancy of summation along these crooked paths in natural order squares holds only when the base is *prime*. In larger squares there are more crooked paths. In a 7×7 square there are four such sets and the summation of 175 holds for every set of crooked paths.

Figures 2, 3, and 4 are also squares. Let us see where 1, 6, 11, 16, 21, the first column of figure 1, is in each of them. In figure 2 it is a broken diagonal, up and to the right. All of the other columns of figure 1 are parallel diagonals. In figure 3 this first column is along an elongated knight's move, three cells down and one cell right; and all the other columns are on parallel paths. In figure 4, it is along a knight's move, two cells down and one cell right; and all the other columns are on parallel paths. Follow any set of paths in any one of these squares through the others; and you will find that each path sticks together and each set of paths sticks together.

Let us summarize what we have observed about the 5×5

natural order square: We have six sets of five paths each: five rows whose summation is not constant; five columns whose summation is not constant; five diagonals in one set whose summation is constant, 65; five diagonals in the other set whose summation is constant, 65; five paths along the knight's move whose summation is constant, 65; and five paths along the elongated knight's move whose summation is constant, 65. Moreover we have noticed a decided tendency of the members of a given path to stick together, and the paths of a given group to stick together in such transformations as we have made.

As we are looking for magic squares, we cannot avoid wondering if we can put the rows along the knight's move paths and the columns along the elongated knight's move paths, and if we can, will the other four sets of paths whose summation is 65 arrange themselves as rows, columns, and diagonals. It will do no harm to try.

In a blank 5×5 square we enter 1, 6, 11, 16, 21, the first column of figure 1 along the path three cells to the right and one cell down as in figure 5. Then, beginning with 1 we enter the first row, 1, 2, 3, 4, 5, along the path two cells to the right and on one down as in figure 6. Then, beginning with 6, 11, 16, and 21, we enter the other rows of figure 1, as shown in figure 7. What we hoped would happen has happened. The members of each path have kept together; the members of each group have kept together; we have a pandiagonal magic square, i.e., one in which all the diagonals, broken as well as whole, have the same summation as the rows and columns.

FIG. 5

1				
			6	
	11			
				16
		21		

FIG. 6

1				
		2	6	
	11			3
	4			16
		21	5	

FIG. 7

1	10	14	18	22
19	23	2	6	15
7	11	20	24	3
25	4	8	12	16
13	17	21	5	9

The columns of figure 1 may be arranged in any order, and the rows of the resulting square may be arranged in any order; and everything we have done with figure 1 can be done with the square thus obtained. This opens up a possibility of calculating the number of 5×5 magic squares of this kind that are possible;

but look out for duplications in making your calculation.

This method of constructing a pandiagonal magic square has the advantage of giving some insight into the structure of any and every square array. There are like paths in cubic arrays. The general move would be A cells along the axis of X, B cells along the axis of Y, and C cells along the axis of Z. Add D cells along a W axis, and you are in four dimensions.

All that has been stated up to this point will hold for the natural order square on any *prime* base. If the base is composite, it will work only for certain arrangements of rows and columns, of which more later. If the base contains 2 once and only once as a factor, it is impossible to get a pandiagonal magic square.

We shall next give a series of transformations of a natural order square, based on the same principle as the above, that brings out other relations. In figure 8 the center column of figure 1 is kept in place; the second column is shoved up one cell;

FIG. 8

1				
6	2			
11	7	3	24	20
16	12	8	4	25
21	17	13	9	5
1	22	18	14	10
6	2	23	19	15
			24	20
				25

FIG. 9

11	7	3	24	20	11	7		
	16	12	8	4	25	16		
		21	17	13	9	5		
		10	1	22	18	14	10	
		19	15	6	2	23	19	15

FIG. 10

20	11	7	3	24
8	4	25	16	12
21	17	13	9	5
14	10	1	22	18
2	23	19	15	6

FIG. 11

7	3	24	20	11
4	25	16	12	8
21	17	13	9	5
18	14	10	1	22
15	6	2	23	19

the first column, two cells; the fourth column, down one cell; and the fifth column down two cells. And the numbers in the columns are considered as repeating themselves. This forms a new square in which one set of diagonals in figure 1 have become rows. This makes the summation along the rows 65. In figure 9 we have kept the middle *row* of figure 8 constant and transformed horizontally, sliding rows instead of columns. We have now the summation along the columns 65. And as we have kept the same numbers in each row, the summation of the rows remains 65. Let us look at the diagonals. The sum of one main diagonal, 1, 8, 13, 18, 23 is 65; and the sum of all the diagonals in the other set is 65. We have a semi-pandiagonal square.

Figure 10 was obtained from figure 9, and figure 11 from figure 10 in the same way figure 9 was obtained from figure 8. Figure 10 is fully pandiagonal, and figure 11 semi-pandiagonal for the other set of diagonals.

Let us follow the path 1, 2, 3, 4, 5 through figures 8, 9, 10, 11, and an imagined further horizontal transformation. In figure 8 it is a diagonal; in 9, a knight's move path; in 10, an elongated knight's move path; in 11, a broken diagonal of the other set; and in the next transformation we would find it a column. Take any one of the 30 different paths in figure 8, follow it through this series of transformations, and you will find that it goes through the same cyclic changes of path.

There is one other variety of 5×5 magic square that can be derived from the natural order square. It is not pandiagonal at all; only the main diagonals have the summation of 65. These diagonals will be the middle row and the middle column of our original square. Figure 8 has one of them, 11, 12, 13, 14, 15. We want the other, 3, 8, 13, 18, 23, for the other diagonal. Therefore we put the two diagonals in a blank 5×5 square, figure 12, and ask ourselves how we can fill it out, making it a legitimate

Fig. 12

11				3
	12		8	
		13		
	18		14	
23				15

Fig. 13

11	24	7	20	3
4	12	25	8	16
17	5	13	21	9
10	18	1	14	22
23	6	19	2	15

transformation of figure 8. On the supposition that the paths in a group stick together, we say every column in figure 8 must be a diagonal in figure 12 we make 11, 16, 21, 1, 6, a column in figure 8, a diagonal parallel to 3, 8, 13, 18, 23 in figure 12, getting a part of figure 13. Then beginning with 12, 14, and 15 in figure 12 we fill in the rest of figure 13.

In all the transformations of the 5×5 square in this paper, the members of every path have kept together, and the groups of paths have kept together. This is due to a property of square arrays, not simply of magic squares. It happens to work in the construction of magic squares.

The rows and columns of figure 1 may be arranged in any order, and the transformations will work. They will also work for a natural order square on any *prime* base. In larger squares there will be more full pandiagonal squares between the two semi-pandiagonals.

As the general methods used in this paper apply to composite as well as to prime bases, some hints as to the handling of them may be in order. The most essential thing is to get the rows and columns of the natural order square in an order that will work. This order is bound to show itself in some form in all methods of constructing such squares.

For a 9×9 square use either I or II, and proceed as follows:

	I			II	
A	B	C	A	B	C
1	2	3	1	2	3
5	6	4	6	4	5
9	7	8	8	9	7
—	—	—	—	—	—
15	15	15	15	15	15

Take a number from any column, *A*, *B* or *C*, say 1 from *A* in I; then take a number from either of the other columns, say 6 from *B;* then a number from the third column, say 4 from *C;* then, going to the columns in the same order, take another number, say 5 from *A*, 7 from *B* and 8 from *C;* then, going to the columns in the same order, take the remaining number, in this case, 9 from *A*, 2 from *B* and 3 from *C*. This gives a possible order for either rows or columns of the natural order 9×9 square, 1, 6, 4, 5, 7, 8, 9, 2, 3.

Figure 14 gives a 9×9 square with the columns arranged in the above order and the rows arranged in another good order (derived from II).

Columns

		1	6	4	5	7	8	9	2	3
	1	1	6	4	5	7	8	9	2	3
	2	10	15	13	14	16	17	18	11	12
R	3	19	24	22	23	25	26	27	20	21
O	6	46	51	49	50	52	53	54	47	48
W	4	28	33	31	32	34	35	36	29	30
S	5	37	42	40	41	43	44	45	38	39
	8	64	69	67	68	70	71	72	65	66
	9	73	78	76	77	79	80	81	74	75
	7	55	60	58	59	61	62	63	56	57

This square may be treated just as we have treated the 5×5 square; but if the move A cells to the right and one cell down is used for the columns, then the move $A\pm3$ or $A\pm6$ to the right and one cell down should not be used for the rows. 3 is a factor of 9.

For a 4×4 square, use

A	B
1	2
4	3
—	—
5	5

to get possible orders. The 4×4 square is too small for an elongated knight's move. Instead use the knight's move both

For an 8×8 square, use

A	B	C	D
1	2	3	4
8	7	6	5
—	—	—	—
9	9	9	9

For a 12×12 square, use

A	B	C	D	E	F
1	2	3	4	5	6
12	11	10	9	8	7
—	—	—	—	—	—
13	13	13	13	13	13

horizontally and vertically. In this case, for the second set of transformations, you will have to make two vertical transformations before proceeding horizontally.

Unless an even square is a power of 2, it presents some other complications, as do all squares that contain more than one prime factor.

DAVID EUGENE SMITH
1860–1944

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The death of David Eugene Smith ends the career of a great leader in the teaching of mathematics. His interests were unusually extensive but most of all he was an untiring worker for the cause and improvement of the teaching of his favored subject, mathematics. He will be remembered as a great teacher, a noted scholar, an authority as an historian, and a writer on mathematics.

Professor Smith was born in Cortland, N. Y. on January 21, 1860. His undergraduate work was done in Cortland State Normal School and in Syracuse University from which he graduated in 1881. In 1887 he received the Ph.D. degree from that institution.

Having been admitted to the bar after his graduation he took up law as a career and practiced law for three years until 1884. He then decided to become a teacher of mathematics and taught in the Cortland State Normal School until 1891. At that time he accepted a professorship in Michigan State Normal College which he held until 1898. The next three years he served as principal of the Brockport State Normal School and in 1901 he became a professor in Teachers College, Columbia University, a position which he held for twenty-five years, retiring in February 1926. Enjoying the best of health for many more years he continued to give his energy and time to the cause of mathematics for another decade and a half.

Nationally and internationally Professor Smith was probably best known as the author of several exceedingly successful series of textbooks on elementary, secondary and college mathematics published by Ginn and Company. His career as a writer of

mathematical textbooks began in 1895 and since then he has been either author or coauthor of about forty such books.

Being an excellent teacher students came to him from all parts of the country and many from distant lands. To express their appreciation and to demonstrate the high regard they had for him personally, for his views and his methods his students and colleagues honored him at a dinner on April 27, 1926, when they presented to Teachers College a portrait of Professor Smith painted by Leo Mielziner, an artist known for his excellent portraits of men of prominence in public life. A series of textbooks recording his views on the organization and teaching of mathematics has had much influence on the development of methods courses because they offered real professional training whereas before his time the training of teachers of mathematics consisted largely of reviews of subject matter, specific suggestions as to ways of teaching and applications showing the usefulness of the subject.

A large part of Professor Smith's life was spent in research work in his special field, the history of mathematics. The search for manuscripts, books, instruments and pieces of art made him an extensive traveler and collector and took him to almost every country. He crossed the Atlantic eighty times and made two trips around the world. His collection numbers nearly 3000 items including portraits of famous mathematicians and hundreds of instruments used in the study of numbers. His first book on the history of mathematics appeared in 1896, but his most outstanding contribution to this field is a two volume series of a *History of Mathematics* published in 1924 and 1925. Other well known historical works are: *Rara Arithmetica* containing a history of arithmetics published before 1601; *Our Debt to Greece and Rome in Mathematics;* and *Historical-Mathematical Paris.*

As busy as he was on his own projects David Eugene Smith gave his time generously when the interest of the advancement of mathematics was involved. He took active part in most of the associations of teachers of mathematics and was a member of several associations of foreign countries. He was first vice president and later president of the International Commission on the Teaching of Mathematics. He served as mathematics editor of several encyclopaedias.

Professor Smith's long and brilliant career ended with his death in July 1944, but the influence of his life and work upon the teaching of mathematics will last long into the future.

AN EXERCISE IN NAMING INORGANIC COMPOUNDS

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One objective of a course in general chemistry is the correct usage of chemical terms. A part of the student's vocabulary must obviously be the names of compounds. The authors of most textbooks devote considerable space to nomenclature but often the rules of naming are incomplete, or scattered. The student may never gain a mastery of nomenclature because his attention has not been directed to enough examples and because he has not had sufficient actual practice in naming compounds.

The exercise described here may be used as a laboratory drill or as home work. In it the student must apply the rules to a sufficient number and variety of examples so that he should develop confidence in his ability to use names and formulas in a precise way.

In organizing the exercise it has been the purpose to present the rules in a simple manner. It is recognized that strict accuracy must at times be sacrificed in order to avoid complexity and confusion. Thus the Pb^{++} ion is called lead rather than the more accurate term plumbous, and Cr^{+++} is referred to as chromium rather than chromic.

The naming of complex compounds after the system of Werner has not been included. These compounds should be considered at a later time or in advanced courses. Also, the basic salts, peroxides, peroxy acids and condensed acids have been omitted.

NAMES AND FORMULAS

NAME OF STUDENT______________________ DATE ________

Consult the table of elements in the textbook for the names and symbols of the elements. The words copper, gold, iron and tin are not used in naming the compounds of these elements. Copper compounds are cuprous or cupric; gold compounds are aurous or auric; the compounds of iron are ferrous or ferric, and those of tin are stannous or stannic.

A. Naming of Binary Compounds

The binary compounds are those which contain only two elements. In naming these compounds both elements are named

and the suffix "ide" is attached to the name of the second element. To shorten the name, one or more syllables may be dropped from the name of the second element before "ide" is added. Thus MgO is magnesium oxide, and $MgCl_2$ is magnesium chloride.

Because some elements have more than one valence, two elements may form two or more compounds with each other. Two plans are usually used to distinguish such compounds.

(1) *Both elements are non-metals*—The number of atoms of the second element in the formula is indicated by the prefixes "mono-, di-, tri-, tetra-, penta-, and hexa-." Thus SO_2 is sulfur dioxide and SO_3 is sulfur trioxide.

(2) *The first element in the formula is a metal*—The ending "ous" is used to denote the lower valence of the metal and the ending "ic" indicates the higher valence. $FeCl_2$ is thus ferrous chloride and $FeCl_3$ is ferric chloride. Name the following compounds.

Na_2O	CuI	N_2O	CCl_4
FeS	CO	NO nitric	H_2S
Fe_2S_3	CO_2	NO_2 nitrogen	H_2Se
$AgBr$	P_2O_3	N_2O_3	PbS
CuO	P_2O_5	N_2O_4	LiH
Cu_2O	PCl_5	N_2O_5	Ca_3P_2
Al_4C_3	PBr_3	CaC_2	As_2O_3
SiO_2	SiC	Mg_3N_2	As_2O_5

B. Naming of Bases

The hydroxyl ion ($\overline{OH}$) is present in the bases listed and the compounds are called hydroxides. The bases are named like the binary compounds. Name the following bases.

$AgOH$	$Co(OH)_3$	$Hg(OH)_2$	$Ni(OH)_2$
$Al(OH)_3$	$CuOH$	KOH	$Pb(OH)_2$
$Ba(OH)_2$	$Cu(OH)_2$	$LiOH$	$Sn(OH)_2$
$Bi(OH)_3$	$Cr(OH)_3$	$Mg(OH)_2$	$Sn(OH)_4$
$Ca(OH)_2$	$Fe(OH)_2$	$Mn(OH)_2$	$Sr(OH)_2$
$Cd(OH)_2$	$Fe(OH)_3$	$Mn(OH)_3$	$Sb(OH)_3$
$Co(OH)_2$	$HgOH$	NH_4OH	$Zn(OH)_2$

C. Naming of Acids

The same element, because it may have more than one valence may form several acids which differ from each other in the

amount of oxygen they contain. The name of the best known of these acids usually ends in "ic." An example of such an acid is chloric acid, $HClO_3$. If the acid contains less oxygen, the name ends in "ous," as chlorous acid, $HClO_2$. The acid HClO is called hypochlorous acid, the prefix "hypo" denoting less oxygen. If the acid contains more oxygen than the one with the name ending in "ic," the ending "ic" is retained and the prefix "per" added. Thus $HClO_4$ is perchloric acid.

Binary acids contain no oxygen. HCl is such an acid; it may be called hydrogen chloride, but the name does not suggest acid properties, so the name hydrochloric acid is generally used. This name shows the use of the prefix "hydro" and the suffix "ic" attached to the name of the non-metal. These rules may be summarized in naming the acids of chlorine.

hydro—ic	ous		ic	
HCl	HClO	$HClO_2$	$HClO_3$	$HClO_4$
hydrochloric acid	hypochlorous acid	chlorous acid	chloric acid	perchloric acid

The prefixes ortho, pyro, and meta are used to distinguish the acids formed by different degrees of hydration of the oxide from which they are derived. The most hydrated acid is called the ortho and the least hydrated is the meta.

(1) The following acids are the most common and hence their names end in "ic." Name them.

H_2CO_3	HIO_3	$HBrO_3$	H_4SiO_4
H_3PO_4 ortho	H_3AsO_4 ortho	H_2SeO_4	$HClO_3$
HPO_3 meta	HNO_3	H_3BO_3 ortho	H_2CrO_4
$H_4P_2O_7$ pyro	H_2MnO_4	HBO_2	
H_2SO_4		H_2SiO_3 meta	

(2) Each of the following acids is related to one of the "ic" acids listed above. Study the relationship and apply the rules of naming.

H_2SO_3	HClO	HI	H_3AsO_3 ortho
$HClO_2$	H_3PO_3	HNO_2	$HAsO_2$
HBr	HF	$H_2N_2O_2$	HCl
HIO_4	HBrO	$HClO_4$	$HMnO_4$ per
H_2S		HN_3	

D. Naming of Salts

A salt is named from both the metal and the acid from which it is derived. The name of the metal ion is given first.

(1) Salts of binary acids, for example, NaCl, contain only two elements; hence they are named as binary compounds. (Section A)

(2) Salts of oxygen acids.

The relationship between salt names and acid names may be stated very briefly. (a) the suffixes "ic" and "ous" which appear in names of acids are changed to "ate" and "ite" respectively in naming salts. (b) The prefixes "hypo," "per," "meta" and "pyro" are retained in naming salts. The prefix "ortho" is often omitted in salt names.

In naming acid salts the metal and hydrogen are both named. For example, $NaHSO_4$ is sodium hydrogen sulfate. The number of molecules of water in hydrates should be indicated, for example $CaSO_4 \cdot 2H_2O$ is calcium sulfate dihydrate.

$AlPO_4$	$NaKSiO_3$	$Ni(NO_3)_2$	NH_4NO_2
$AgCl$	$NaHSO_3$	$PbCrO_4$	Hg_2SO_4
K_2CO_3	Na_2SO_3	Na_3PO_4	$HgSO_4$
$KHCO_3$	$Cr(NO_3)_3$	Na_2HPO_4	$Na_2CO_3 \cdot 10H_2O$
$FeSO_4$	$CoSO_4$	NaH_2PO_4	$CuSO_4 \cdot 5H_2O$
$Fe_2(SO_4)_3$	MnS	NH_4HCO_3	$Ca(IO_4)_2$
K_2MnO_4	$Ca(HSO_3)_2$	K_3AsO_4	$Pb_3(AsO_4)_2$
$NaClO_3$	$Ca(BrO_3)_2$	Ag_3AsO_3	$Al(IO_3)_3$
$NaClO_2$	Mg_2SiO_4	$Zn(NO_3)_2$	CdI_2
$NaClO$	$KAsO_2$	$Ba(NO_2)_2$	$AgBO_2$
CaF_2	$NaPO_3$	$Mg(ClO_3)_2$	$Mg_2P_2O_7$
$FeBO_3$	$SnCl_2$	$Mg(ClO_4)_2$	$KMnO_4$
Na_2SiO_3		$RaBr_2$	

E. Formula Writing

Refer to the formulas of the acids and bases given above for valences of ions. Suppose it is required to write the formula for silver sulfite. This salt can be derived from silver hydroxide and sulfurous acid. (Note the relationship between "ite" and "ous.") In sections B and C, the formulas of these compounds are written as AgOH and H_2SO_3, hence the silver ion has a valence of positive one and the sulfite ion a valence of negative two. The formula of silver sulfite is therefore Ag_2SO_3.

lithium nitrate
cuprous chloride
cupric carbonate
mercurous chloride
mercuric bromide
barium metaphosphate
magnesium orthoarsenate
aluminum metasilicate
nickel nitrite
cobaltous sulfide
bismuth sulfate
cadmium nitrate
chromium sulfate
strontium chromate
ammonium orthoarsenite
stannic chloride
lead iodide
ferrous sulfite
ferrous carbonate
ferric chloride
zinc selenate

calcium orthophosphate
calcium chlorate
potassium iodate
silver bromate
potassium sulfite
potassium hydrogen sulfite
potassium periodate
sodium perchlorate
sodium nitrite
ammonium nitrate
calcium metasilicate
aluminum oxide
barium chloride dihydrate
barium metaborate
ferric oxide
antimony sulfate
silver chromate
potassium hypobromite
aluminum fluoride
sodium manganate
manganous bromide

F. Miscellaneous Names

Although not binary compounds, the salts of hydrocyanic acid, HCN, are called cyanides; for example, KCN is potassium cyanide.

Names of some complex salts:

$K_4Fe(CN)_6$ potassium ferrocyanide
$K_3Fe(CN)_6$ potassium ferricyanide
K_2SiF_6 potassium fluosilicate
K_2PtCl_6 potassium chloroplatinate

The prefix "thio" is used in naming compounds in which sulfur is said to replace oxygen.

KCNS potassium thiocyanate
$Na_2S_2O_3$ sodium thiosulfate
$BaCS_3$ barium thiocarbonate
$(NH_4)_2SnS_3$ ammonium thiostannate

Write the name for $(NH_4)_3AsS_4$

When you change address be sure to notify Business Manager Ray C. Soliday, P. O. Box 408, Oak Park, Ill.

THE SELECTION OF BOOKS IN THE FIELD OF CHEMISTRY

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Chemists have built their reputation on achievement. Merchants find that the words "chemistry" and "laboratory" inspire confidence and that their use in advertisements increases profits. Recent events have added "synthetic" and "plastics" to the list of chemical terms that stir the public mind. To the average American chemistry stands for romance, for research, for integrity, and for new comforts. Chemistry is the glory of its practitioners and the benefactor of all.

The confusion about the exact nature and scope of chemistry is not limited to the minds of the uninformed. Attempt, if you will, to draw a sharp line between physical chemistry and physics, or between organic chemistry and physiology. Formally defined, chemistry is "the science of the ultimate composition and constitution of matter, of the mutual reaction between two or more substances, and of the influence of factors such as change of temperature, pressure, or extent of surface upon the stability of a substance and its relation to other substances."[1] Strictly speaking, physics, chemistry's neighbor, does not deal with changes in the composition of matter, leaving that to chemistry, but the quantitative measurement of physical properties is intimately connected with the constitution of matter. Moreover, in many phenomena, x-rays, for example, both physicists and chemists have such vital interest that neither group would concede ground to the other. Even in these areas of common interest, however, chemistry is concerned primarily with what matter *is*, while physics is concerned primarily with what matter *does*.

Chemists use the method and the symbols of mathematics, but in addition they have their own distinctive way of expressing changes in composition. For example, $C+O_2=CO_2$. That is, when carbon burns, each atom of carbon unites with two atoms of oxygen to form carbonic acid gas.

The chemist investigates substances; in organic chemistry the substances are carbon compounds; in inorganic chemistry they are non-carbon compounds and elements. The chemist analyzes

[1] John Johnston. Chemistry. In *The Development of the Sciences*, 75.

these substances (analytical chemistry) and builds them up again from their parts (synthetic chemistry). He studies the relations between the properties of substances and the constitution of these substances (physical chemistry). He invents new materials more useful than those found in nature. He investigates the compounds and processes occurring in plants and animals (biochemistry). The results of these studies affect our lives at every turn.

The romance of chemistry, the fascination of controlling matter, and the possibility of great economic gain through chemical knowledge have created a demand for a heterogeneous chemical literature. Authors have been quick and generous in answering this call. Their product, falling into categories similar to those of the literature of physics, but differing from the literature of physics in quantitative distribution among the categories, may be classified as follows:

1. Popular interpretations
2. Serious, philosophical treatises
3. Elementary, general textbooks
4. Advanced textbooks
5. Laboratory manuals
6. Books of applied chemistry
7. Reference books.

Popular interpretations are non-technical books written to interest ordinary readers in chemistry and at the same time to provide them with accurate information on the subject. Comprehensiveness must be sacrificed for simplicity and entertainment. Yet these non-technical books, emphasizing the more spectacular developments in chemistry, are useful in schools as supplementary reading to lift the lagging interest of the beginning science student. The demand for popular interpretations of chemistry is not great, but it is constant and significant. Listed below are the qualities that make for excellence in books of this type.

Of first importance are:

1. Accuracy of information. This is the first requirement in every scientific book.

2. Up-to-dateness of material. Obviously, in a field that is constantly developing, this point is really part of no. 1.

3. Minimum mathematical content. The inclusion of mathe-

matics above the high school level discourages most readers from completing the book. It is desirable that books of this type contain no calculations.

4. Elementary, yet adult, treatment, so the reader of average intelligence and average education can comprehend the book without previous knowledge of chemistry.

5. Perspective. The topics included in the book should be chosen by the author partly for significance, as well as for interest.

6. Attractive appearance and easily read type. These qualities not only make reading more enjoyable, but also create the initial interest in the book.

Of second importance are:

1. Good illustrations that help to explain the text, enliven the book, and appear where needed. Pictures of industrial installations and of laboratory equipment serve this purpose admirably.

2. Material about the lives of great chemists and demonstration of the daily utility of chemistry. These features make the subject real to the reader.

3. A table of contents and a list of similar books for supplementary reading.

Serious, philosophical treatises on the aims, methods, development, and present state of chemistry comprise the second class. Books of this type are less numerous in the field of chemistry than in physics, perhaps because chemists have been more eager to apply their knowledge than to speculate about the nature of matter. Fortunately for the evaluator, unqualified writers rarely attempt works in this realm. We are, however, not relieved of the task of careful scrutiny of philosophical treatises on chemistry. Let us now outline rigid standards for selection.

Of first importance are:

1. Up-to-dateness. To be helpful in other than historical study, the book must be written in the light of the latest findings in chemistry.

2. Adequate documentation. The reader wants assurance that a complicated super-structure is not erected on a foundation of sand.

3. Careful definition of terms in order to avoid ambiguity and loose thinking.

4. Agreement in broad principles and in methodology with the best philosophical thought.

5. Extensive bibliography, aiding the reader in further study on the same subject.

Of second importance are:

1. A table of contents to indicate the scope of the book.
2. A preface to explain the point of view of the writer.
3. A detailed index for reference purposes.
4. A title descriptive of the subject-matter.

Elementary, general textbooks of chemistry are probably the most used category that we consider in this paper. They are needed in the introductory chemistry courses of high schools and colleges. Thus, teachers as well as librarians, are interested in the features that distinguish good, elementary textbooks of chemistry from inferior works of the same type, especially because of the increased emphasis on chemical education during wartime.

Of first importance are:

1. Requirement of no mathematics above the high school level. Students of elementary chemistry are usually in the last two years of high school or in the first year of college.

2. Stress on basic principles. Separation of the most important material from the less important through the use of different sizes of print or by means of footnotes is helpful. Basic principles must not be obscured by detail.

3. Adequate coverage of the whole field. One topic should not be emphasized at the expense of another.

4. Accuracy and up-to-dateness. Revised editions are often more accurate than first editions, because the author has had opportunity to make corrections.

5. Careful definition of chemical terms.

6. Clear, uniform diagrams that help to explain the sections in which they appear and to interest students in the subject. Inclusion of the periodic table is essential.

7. Thorough treatment of the applications of chemistry to problems. In addition to showing the usefulness of chemical principles, this increases the student's will to learn. Military applications are particularly in demand today.

8. An abundance of problems for diagnostic and practice purposes.

Of second importance are:

1. The use of conventional abbreviations and symbols.
2. A table of contents to aid the teacher in planning a course and to give the student perspective in study.
3. Pictures of chemical apparatus and of chemists.

Of third importance are:

1. Prefatory suggestions to the teacher on teaching methods, on the relative importance of different topics, and on courses of study.
2. A glossary of chemical terms.

Advanced textbooks, that is, specialized books for college students who have completed a general course in chemistry, are the fourth group. They are less comprehensive than elementary textbooks and have greater mathematical content. Previous knowledge of chemistry and in some instances, notably in physical chemistry, knowledge of physics are assumed. Careful selection of advanced textbooks of chemistry must be based on well-formulated criteria.

Of first importance are:

1. The inclusion of the latest findings in the field.
2. Accuracy, insofar as it can be attained, bearing in mind that in some kinds of chemical data, accuracy is being approached, but will not be secured absolutely for many years, if at all.
3. Careful definition of terms.
4. Explanatory diagrams, where they are needed.
5. An attempt to show how the special branch of chemistry under consideration stems from the basic principles underlying all chemistry.

Of second importance are:

1. An index for reference purposes.
2. A carefully-compiled bibliography.
3. The use of conventional abbreviations and symbols.
4. A preface to give the prospective reader some notion of the book.
5. Problems for diagnostic and practice purposes.
6. Discussion of the most important applications of the subject.

Laboratory manuals are guides to the experimental study of chemistry. Inadequate laboratory instruction results in waste of valuable time and in poor training. The criteria, which are similar to those for judging laboratory manuals in other sciences, are as follows:

Of first importance are:

1. Specific directions for performing the experiments. The "cook-book style" is not desirable, however. Good directions save time and prevent discouragement.
2. Simplicity of required apparatus. This is especially important during wartime, when many kinds of apparatus are expensive or not available at all.
3. A sufficient number and variety of experiments to enable the instructor to adapt the manual to different types of classes and to courses of varying laboratory time-allowance.
4. The use of conventional abbreviations and symbols.
5. The inclusion of problems to insure that the student has a good grasp of the theoretical and experimental principles.
6. A short introduction to each experiment, giving the purpose of the experiment.
7. Approximately the same order of topics as is generally followed in textbooks with which the manual is likely to be used.
8. The inclusion of experiments illustrative of the latest developments in the field.
9. In elementary manuals simple introductory experiments acquainting the student with laboratory apparatus are helpful.

Of second importance are:

1. Perforated pages, so that the reports for the experiments may be submitted to the instructor for correction.
2. Spaces provided at the heads of the reports for the name and the desk number of the student and the dates of the experiments.

Of third importance are:

1. A table of contents.
2. Prefatory suggestions to the instructor on the best use of the manual.

Books of applied chemistry have enjoyed a greater increase in popularity recently than has any other category discussed in this paper. This group includes books on chemistry applied to

medicine, dentistry, agriculture, textiles, home economics, and other fields. Chemical applications to warfare are many and important. There has been a flood of books intended to meet this new demand. The very size of applied chemistry book output requires rigid standards for separating the best from the inferior. These criteria are as follows:

Of first importance are:

1. Up-to-dateness. In the chemistry of warfare, particularly, changes in recent years have been great.
2. Accuracy of information.
3. Demonstration of the usefulness of chemistry in solving problems. This, of course, is the primary function of books of applied chemistry.
4. Self-teachability. Many students do not have teachers to help them when difficulties are encountered. Army requirements have encouraged hundreds of young men to study chemistry by themselves.
5. An index.
6. The requirement of a minimum of mathematics. This minimum necessarily varies according to the needs of the special subject.
7. Sufficient theoretical background provided to enable readers with rusty chemical knowledge to derive benefit from the book.
8. Properly located explanatory diagrams.
9. The inclusion of helpful data for reference purposes.

Of second importance are:

1. Review questions to test the student's understanding of the subject.
2. A bibliography to guide the reader in further study of the subject.
3. The use of conventional abbreviations and symbols.
4. A book title and chapter titles that are descriptive of the contents.
5. A glossary of terms and a tabulation of important formulas.

Reference books of chemistry, including compilations of formulas, dictionaries, tables of chemical data, chemical abstracts, and bibliographies, form the last category. These are books used primarily by working chemists. They are generally

expensive. The criteria for their selection are all of the first importance.

1. Accuracy, including recency. In any reference book this is *the one* necessity. If the work is a serial, thorough revision is important.

2. Completeness. One comprehensive reference book is more helpful than several incomplete ones.

3. A detailed, well-arranged index.

4. The use of conventional abbreviations and symbols.

5. Durable binding. If the book is useful, it will receive constant handling.

The thoughtful reader who has proceeded this far, may well ask, "Wherein does the selection of books of chemistry differ from the selection of books of physics?" The answer is that the two fields being very much alike in methods, subject-matter, and findings, are similar in literature also. The similarity of their literatures means that the standards for selection in the two fields are almost the same. Very close scrutiny of the two literatures does reveal some differences, differences which, while not causing great differences in standards of selection, nevertheless make selection of books in chemistry somewhat more difficult than selection in physics. In the first place, there are many more books published in the field of chemistry than in the field of physics. This is true partly because many books that might be classified in applied physics are in practice considered as engineering. Secondly, the literature of chemistry is more highly developed than the literature of physics. Thus, we can find many highly specialized books of chemistry that cannot be duplicated in the field of physics; for example, there are Deuel's *Textbook of Chemistry for Students of Embalming* and Macleod's *Chemistry and Cookery*. There are more bibliographies of chemistry than of physics. There are more doctoral dissertations in chemistry than in physics. Except for the scarcity of philosophical studies in chemistry, it is safe to say that chemical literature is a fuller and a more advanced literature than is that of physics. Therefore, the chief difference in selection in the two fields is one of complexity, not of method. Expert selection of chemistry books offers a challenge that only the exceptional bookman can face with well-founded confidence.

SUPPLEMENTARY DATA

Important publishers of chemistry books:

Appleton-Century, Blakiston, Cambridge, Chapman, Chemical Publishing Company, Crowell, Ginn, Harper, Holt, Longmans, McGraw-Hill, Macmillan, Oxford, Prentice-Hall, Reinhold, Van Nostrand, Wiley, and German publishers whose books are not now available.

Some important aids in the selection of books in the field of chemistry:

School Science and Mathematics, Chemical and Engineering News, Chemical and Metallurgical Engineering, Journal of The American Chemical Society, Journal of Chemical Education, Journal of The Franklin Institute, Journal of Physical Chemistry, and Science News Letter.

Readers interested in the broader aspects of book selection and in the selection of mathematics books are referred to the author's article *The Selection of Books in the Field of Mathematics*, which appeared in School Science and Mathematics, May 1943.

The material of this paper has been drawn from reviews in the above publications and others, from personal experience and thinking, and from examination of a large number of books of chemistry. Helpful for information about chemistry itself were the following:

Dixon, Harold B. Chemistry. In *The Encyclopaedia Britannica*, 14th edition, 5, 355.

Johnston, John. Chemistry. In *The Development of the Sciences*. Yale, 1923. 75–127.

SCIENCE TO PROTECT THE PEACE

Sounding the keynote at the opening of the first National Electronic Conference, Ralph R. Beal, Assistant to the Vice President in Charge of RCA Laboratories, urgently pleaded that industrial research never relinquish the harmonious cooperation with the Army and Navy which has been so closely developed during the war. Our armor of science must be strong, said Mr. Beal. Science, which has helped in winning of the war, he added, must continue to assist in preserving the peace.

"If our armies, battleships and bombers are equipped with the latest devices of science, no nation will be anxious to seek a fight" said Mr. Beal. "We know how destructive the weapons of science have been in this war. We know what the robot bomb has done; it makes us shudder to know what might happen were additional forces of science harnessed to its deathly wings. I can tell you, without revealing any military secrets, that based upon what I have seen developed for warfare in the science of radio-electronics alone, another war would be much more destructive.

"It is my urgent plea that our industrial research laboratories continue to work hand-in-hand with our Army and Navy in peace as they have done so magnificently in war. Let us through science put new power behind the wings of the Dove of Peace. That is the new *challenge;* it is our DUTY."

VETERANS EDUCATIONAL PROGRAM

"If one million of our servicemen and women should avail themselves of this opportunity, and a maximum of $500 were spent on them, the total expenditure for education would be—the cost of the war not for one month, not even the cost of the war for one week—but the cost of the war for *two days!*

—Brig. Gen. Hines

NOTES FROM A MATHEMATICS CLASSROOM

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87. Fundamentals of Mathematics. Occasionally one finds a book that is so stimulating and refreshing, and also educational, that one cannot help wishing everybody would read it. And the opportunity, in notes of this kind, to recommend it is irresistible. I refer to Richardson's *Fundamentals of Mathematics* (1941, The Macmillan Co. $3.25). The advertising manager may disapprove of free advertising, but I shall claim that this is merely educational information. The book, according to the preface, is used as a text in the author's courses in Brooklyn College, and includes more than those college courses which now integrate trigonometry, college algebra, and analytics.

Teachers who have majored in mathematics, particularly those who have done some graduate work, will find little that is new in the subject matter. There are chapters on trigonometry, calculus, statistics, cardinal numbers, analytic geometry, probability, a very good presentation of the logic of algebra and of non-euclidean geometry, as well as chapters on impossibilities, and the usual puzzles and recreations. But the valuable part for the ordinary high school teacher is its careful analysis of many concepts that are seldom clearly defined. For example, just what do we actually prove when we check the solution of an equation (page 133)? I feel sure that the book contains many topics that will be totally foreign to the teacher who, in college, took the fifteen required hours in mathematics plus the required course in Methods of Teaching and then started his teaching career. Such teachers can have the gaps in their education filled in by a study of this book; and the "filling in" will be pleasant since the book is written in an entertaining style.

88. What Is An Average? Given a list of numbers, we teach that the average is found by adding the numbers and then dividing by the number of numbers. No pupil ever asks: Is this a definition of *average* or a theorem which follows from some definition? Such a question would be unlikely to occur to a pupil until he has studied deductive geometry. If the statement is a definition then it is reasonable to say that the average speed is 50 mph whenever you go part of a trip at 40 and part at 30 mph. Likewise, a pupil cannot be blamed for thinking that there

must be a "catch" to a statement like the following: A man invests part of \$3000 at 3% and the remainder at 6% so as to get an average rate of 4%. Evidently average does not mean the sum divided by the number of numbers. It means something different every time the teacher uses the word.

If the concept of *average* is discussed in the literature I have missed it, and shall venture to give my own explanation. An average is a number that we select as the representative of a group of numbers just as a congressman is sent to Washington to represent the people in his district. A congressman must by law be a resident of his district, that is, of the people he represents; but the number chosen as an average need not be a member of the group. Thus the average of 6, 8, and 13 is none of these numbers. This, too, happens in many non-mathematical situations; a union of carpenters may select an outsider as their business agent.

When selecting a number to represent the group, we are guided by the hope or expectation that the single number will be as effective or produce the same result as the combined efforts of the group. The congressman must accomplish in Washington whatever his constituents could collectively accomplish. If the pupils have studied or are familiar with the resultant of vectors, we can say that the average is the resultant; it must accomplish what all the others do separately.

With this idea in mind we can see that the different definitions of average are consistent. If we average the weights of five boys, we mean that if all the boys had this average weight the result of weighing the group would be the same as if we weighed each boy separately.

If a plane travels 2 hr. at 200 mph and 6 hr. at 100 mph the result (distance accomplished) is the same as if it had traveled 8 hr. at 125 mph. Hence our *definition* of average for such problems must be such as to give 125, which means that we define average speed as the total distance divided by the total time.

If we invest \$2,000 at 3% and \$4,000 at 6% then our definition of average rate of income must mean that if all the dollars were invested at this one rate the result (that is, income) would be the same as if the separate investments were made.

If a dealer buys 60 suits at \$30 each and 10 suits at \$50 each, the average cost must be defined as a number which applied to all suits will produce the same result (in this case, the total cost) as the different suits at different prices.

89. Different Methods May Be the Same. No reader should assume that the preceding discussion of the notion of *average* is presented in all my classes and that this is my way of introducing the concept. In most cases stating a definition is sufficient, and there is no need to explain why that particular definition is the chosen one. But there are always days (the day before the Christmas holidays, or a day when so many are absent that the day's assignment must be postponed) when something different can be considered. Usually the missing pupils are those who can least afford to be absent, and so the audience is above average and can appreciate the clarification of a concept or a new light on some topic.

Let some pupils go to the board and solve a set like

$$3x+7y=13 \qquad 5x+11y=17.$$

Assign some pupils to use the method of multiplying and adding, and some to use the substitution method (which can be started in four different ways). And, to have a still greater variety of solutions, ask some pupil to solve each equation for x and then equate the values, and some pupil to do likewise but solve both equations for y.

We then compare the different solutions. The pupils are surprised when I say: No matter what method you used, you have all done exactly the same arithmetic. Some place or other in your work you have all multiplied 13 by 11. Look for it. You all multiplied 17 by 7 somewhere or other. You all multiplied 7 by 5, and 11 by 3. Every one of you subtracted 33 from 35, and 119 from 143. No matter what method you used, you did the same arithmetic.

Will this always happen, or is this set a freak?

If it does not always happen, what must be true about the coefficients when it does happen?

In the sets in which it does happen, how do you explain the fact that some pupils think one method is easier than another? What makes a method easy?

As a program for another day, consider the problem:

How many pounds of 60-cent candy and how many of 40-cent candy should be mixed to make 120 lb. worth 48¢ a pound?

This leads to the equation

$$60x+40(120-x)=48(120).$$

The natural tendency is to remove parentheses, multiply 120 by 40 and by 48, and so forth. But notice:

Merely by *looking* at the equation we can see that there are 60–40 or 20 x's in the left member. Also, there are 48 one hundred twenties in the right member, and only 40 of them in the left member, leaving a surplus of 8 one hundred twenties in the right member. Hence the 20 x's must equal the 8 one hundred twenties. Or, $x=8\times 120\div 20$ or 48.

If the pupil cannot follow this argument, it becomes clear if we remove parentheses and transpose but merely indicate the multiplications instead of doing them. Thus

$$60x-40x=48(120)-40(120).$$

There are many other problems in which the work is lessened by indicating rather than doing operations. In fact, while algebra develops many commendable habits, it also teaches "Never do something because you are told to do it; try to find a way of not doing it." Lest some parent criticize this teaching, we can add that the corollary is "But be sure to obtain the desired result."

90. Three Cats, Three Mice, Three Days. The boys who return on furloughs from the armed services tell me that examinations invariably involve a problem about the rate of work, like:

Five sailors in 10 days can make 15 rafts. How long will it take 8 sailors to make 12 rafts? Or, how many rafts can be made by 9 sailors in 20 days? Or, how many sailors are needed to make 18 rafts in 4 days?

This is a practical version of the old problem about three cats catching three mice in three days. I have tried various explanations of such problems and will present the one which has been most successful.

Let us adopt the proposition that work produces results, and classify the data as (1) the productive items and (2) the results. The sailors and working days are productive items and the rafts are the result. Hence we can write:

$$5 \text{ sailors}\times 10 \text{ days}=15 \text{ rafts}.$$

Treat this statement as an equation; then we may multiply or divided both sides by any number, remembering that a product is multiplied if one of its factors is multiplied. For example,

$$\begin{aligned}
10 \text{ sailors}\times 10 \text{ days}&=30 \text{ rafts},\\
5 \text{ sailors}\times \tfrac{1}{3} \text{ of } 10 \text{ days}&=5 \text{ rafts},\\
1 \text{ sailor}\times 10 \text{ days}&=\tfrac{1}{5} \text{ of } 15 \text{ rafts},\\
5 \text{ sailors}\times 1 \text{ day}&=1/10 \text{ of } 15 \text{ rafts}.
\end{aligned}$$

Usually I do not need to say more. The boy sees at once how to solve any such problem.

LOOKING TO THE FUTURE

What are you, as a teacher of mathematics or science in these busy war days, doing about your own personal development as a teacher? What are you doing to increase your knowledge of current progress in the fields of applied mathematics and science? What are your ideas of a program for mathematics and science teaching in the post war world? Can you afford to miss the forty-fourth annual meeting of the most alert group of science and mathematics teacher in the country?

On November 24 and 25 in the Stevens Hotel in Chicago, ample facilities will be available to display the latest in the text-book and apparatus fields. Among the speakers will be the following:

Harl R. Douglas, Director, College of Education, University of Colorado.

Frederick F. Yonkman, Chief Pharmacologist, Ciba Pharmaceutical Products.

Col. L. W. Prentiss, Deputy Director, Troop Training Division, Army Service Forces.

C. M. Ripley, General Electric Company.

Jonathan Forman, Editor, *Ohio State Medical Journal.*

Louis Bromfield, Malabar Farm, Lucas, Ohiol.

John C. Sylvester, Abbott Laboratories.

Gustav Egloff, Universal Oil Products Company.

Watson Davis, Director, Science Service, Washington, D. C.

Mark H. Ingraham, University of Wisconsin Mathematics Dept.

Teachers who attend the annual meeting of the Central Association of Science and Mathematics Teachers will go back to their work with new vigor. The exchange of ideas with fellow teachers, the contacts with speakers, books, and apparatus, and the atmosphere of friendliness will all contribute to greater class room accomplishment.

How else could you get so much for so little investment of time and money? Avail yourselves of opportunity. Meet your old friends and make new friends in Chicago on November 24 and 25.

HAROLD METCALF, *Secretary*

SOME NEWER FORMS OF THE RECOGNITION TEST

James D. Teller
*The Adjutant General's Office, War Department**

Two types of testing techniques are in common use for instructional purposes in science and mathematics, the recall and the recognition. The recall technique embraces such forms as the essay type test, the short answer test, and the one-word completion test. The recognition technique includes the true-false test and the multiple choice tests. The latter may require the choice of the right answer or of the wrong answer from a list of from two to numerous responses, and it may be arranged in paragraph form, in vertical columns for matching, or in the so-called master-list technique.

The recall technique may be made to cover small units of subject matter, and lends itself to the grouping of responses. In so far it is instructive and diagnostic. However, it does not permit of ready analysis, and provision must be made for too many variable responses in the item study form. Hence, responses are not easily diagnosed for a group study. Moreover it is extremely difficult to make recall tests thoroughly objective and reliable, even though they may have a high validity.

Notwithstanding these objections, present instructional tests have drawn largely on the recall technique. This is not hard to understand when we realize that many testmakers still feel that the recall technique tests something that the recognition test does not. Recent studies, however, tend to overthrow this conclusion, and to show that the ability to recall correlates to a high degree with the ability to recognize.

Of the recognition techniques, the true-false, or a combination of this with the recall technique known as the modified true-false, has been most commonly used by the makers of instructional tests. Since the latter has all of the disadvantages of the recall test, it will not be considered further. The true-false technique may be adapted to small units, and may be used to diagnose particular facts. As an instructional form, however, it leaves much to be desired. Not only does it not group facts as to facilitate learning, but it defeats the learning process by encouraging guessing and discouraging synthesis and organization.

* The views expressed in this paper are not to be taken as representing those of the War Department.

The multiple choice tests enable one to group the individual true-false statements in such a way as to facilitate the organization of facts. However, it is difficult to cover small units of work with the multiple choice techniques. Thus, the diagnosis of particular learning difficulties is impossible.

The multiple choice techniques discourage guessing to such an extent that it may be ignored from the standpoint of statistics. This guessing, however, is significant from an instructional point of view. This may be illustrated by reference to a particular item in the right answer form of the multiple choice test. Consider the following example:

<u>4</u> (1) Substances which are solid at ordinary temperatures include 1. gasoline; 2. kerosene; 3. benzene; 4. paraffine.

If the student is now instructed to place the number of the one right answer on the blank, he is expected to make four true-false decisions, namely:

F (a) At ordinary temperatures gasoline is a solid.
F (b) At ordinary temperatures kerosene is a solid.
F (c) At ordinary temperatures benzene is a solid.
T (d) At ordinary temperatures paraffine is a solid.

Now if we wish to correct the student's score for guessing on a series of such exercises, we usually use the formula:

$$\text{Score} = \text{Number right} - \frac{\text{Number Wrong}}{(N-1)},$$

where N stands for the number of possible responses to an exercise.

In this case $N=4$. Thus, the formula becomes:

$$\text{Score} = \text{Number right} - \frac{\text{Number Wrong}}{3}.$$

Statistically, the correction is probably not essential. In other words we arrive at the score by counting the number of right responses and ignore the correction for guessing.

From an instructional standpoint, however, the guessing is significant. To illustrate, suppose the student knew that gasoline, kerosene, and benzene were not solids, he could immediately write the correct response since he knows that one of the four responses must be right. He may or may not know that paraffine is a solid. Thus, the item has failed to diagnose the student's response in regard to paraffine.

In order to diagnose each response, the directions for a right answer test could be stated as follows: On the blank before each

sentence place the number of any ending which is *correct;* if no ending is correct, place a zero (0) in the blank.

The following item illustrates the use of the zero variation suggested by these directions:

0 (4) Substances which are solid at ordinary temperatures include 1. gasoline; 2. kerosene; 3. benzene; 4. water.

In this way we force the student to make a true-false decision on each part of a given exercise, and the guessing may be ignored from a statistical point of view.

The zero variation may be used in any of the multiple-choice techniques.

The following directions and exercises will illustrate its use in the wrong answer type of response: On the blank before each sentence place the number of any ending which is incorrect; if all endings are correct, place a zero (0) on the blank:

4 (3) Substances which are liquid at ordinary temperatures include 1. gasoline; 2. kerosene; 3. benzene; 4. paraffine.

0 (2) Substances which are liquid at ordinary temperatures include 1. gasoline; 2. kerosene; 3. benzene; 4. water.

The zero variation, however, does not overcome all of the objections which we raised to the use of the multiple-choice techniques for instructional purposes. We shall still find it difficult to cover small units of subject matter with these techniques. This probably explains why they have been used so sparingly by the makers of instructional tests.

Thus, we see that each of the common techniques (as well as some not so common) fails to achieve some one of the requirements for an instructional test. Some testmakers have overcome this difficulty by using a combination of techniques. One common combination is that of the completion and true-false techniques. Any such combination, however, will have the disadvantages of the various techniques employed, and will complicate analysis for group diagnosis. The primary advantage of a combination is to enable the examiner to cover smaller units than he could otherwise.

Another possibility is to integrate various testing techniques so as to satisfy the requirements of tests for instructional purposes. It has been pointed out that the recognition techniques are to be preferred to the recall techniques for the purposes of objective measurement. Moreover, the assumption has been made that the abilities measured by the two techniques correlate to a high degree. Further, the opinion has been expressed

that, of the recognition techniques, the true-false is least efficient in the promotion of the learning process. Consequently, the solution to our difficulties is some form of integration of the multiple choice techniques. Two methods of integration will be suggested.

The following directions will illustrate the first method of integration:

Show your understanding of the items by marking in one of four possible ways:

(1) On the blank *before* any sentence in which *only one* ending is *correct*, place a capital letter R (R = Right) followed by the *number* of the *one correct* ending.
(2) On the blank *before* any sentence in which *all* endings are *correct*, place a capital letter R (R = Right) followed by a capital letter A (A = All).
(3) On the blank *before* any sentence in which *only one* ending is *incorrect*, place a capital letter W (W = Wrong) followed by the *number* of the *one incorrect* ending.
(4) On the blank *before* any sentence in which *all* endings are *incorrect*, place a capital letter W (W = Wrong) followed by a capital letter A (A = All).

Each of these types of responses is illustrated by exercises numbered to correspond with the directions given above and with the exercises previously used in this discussion:

R 4	(1) Substances which are solid at ordinary temperatures include 1. gasoline; 2. kerosene; 3. benzene; 4. paraffine.
R A	(2) Substances which are liquid at ordinary temperatures include 1. gasoline; 2. kerosene; 3. benzene; 4. water.
W 4	(3) Substances which are liquid at ordinary temperatures include 1. gasoline; 2. kerosene; 3. benzene; 4. paraffine.
W A	(4) Substances which are solid at ordinary temperatures include 1. gasoline; 2. kerosene; 3. benzene; 4. water.

A comparison of the four exercises above with the four previously used will show that the integration has been effected by the use of the letters R and W and the changing of zero to the letter A. Any one of the ten possible responses; namely, R1, R2, R3, R4, RA, W1, W2, W3, W4, and WA, will immediately show the nature of the student's reaction to a particular item. Thus, in item (1) above, "R4" shows the instructor that the student knows that paraffine is the only solid in the list. The use of the numeral "4" alone, as in the common type of right answer test, would not show this since, as we have shown, the student might reach this decision by knowing that one of the four answers must be right.

The disadvantage of the first method of integration is that no

provision is made for marking items which have two correct and two incorrect endings. This defect is remedied in the second method of integration which may be illustrated by the following directions:

Show your understanding of the items by marking in the following manner:

(a) Place a *circle* around the *number* before each *correct* ending in the sentence.
(b) *Add* the numbers which you have *circled* and place the *sum* on the blank to the left of the item.
(c) If you do not circle any number in a sentence, place zero (0) on the blank to the left of the item.

The application of these directions to the items previously used in this discussion as well as to an item having two correct and two incorrect endings is shown below:

8 (1) Substances which are solid at ordinary temperatures include 1. gasoline; 2. kerosene; 4. benzene; 8. paraffine.

15 (2) Substances which are liquid at ordinary temperatures include 1. gasoline; 2. kerosene; 4. benzene; 8. water.

7 (3) Substances which are liquid at ordinary temperatures include 1. gasoline; 2. kerosene; 4. benzene; 8. paraffine.

0 (4) Substances which are solid at ordinary temperatures include 1. gasoline; 2. kerosene; 4. benzene; 8. water.

12 (5) Substances which are solid at ordinary temperatures include 1. gasoline; 2. kerozene; 4. carbon; 8. paraffine.

In the second method the integration is effected by the use of addends.* In this method every possible combination of responses is represented by a separate number which ranges from zero to fifteen. The pattern of the student's response to a particular item is easily determined. Thus, in item (5) above, "12" shows the instructor that the student knows that carbon and paraffine are the only solids in the list.

The classroom teacher should have no difficulty in utilizing any of the preceding forms of the recognition test in constructing test items for instructional purposes in science and mathematics.

* The second method of integration was suggested to the writer by Herbert A. Toops. For his discussion of the use of addends in coding, see p. 2272 of the O.C.A. Bulletin No. 110.

Circular maps of the two hemispheres mounted in a single frame may be rotated in unison by one thumbscrew so that points at equal distances north or south of the equator may be brought quickly into true relationships for study. Its use eliminates the distortions on ordinary flat maps.

WHY STUDY PHYSICS?

Sister M. Joan Preising
College of St. Francis, Joliet, Illinois

To many it seems an almost impossible task to assimilate the knowledge of the laws of physics, yet, from our first conscious moment in the day to the last at night, we are constantly applying the laws which govern the physical phenomena about us.

We may study the subject of the laws of physics according to the headings given in a text or we may take the general routine of a day and consider each phenomenon as we meet it.

It is the sound waves from a none-too-welcome alarm clock that are transmitted to our inner ear and the light waves which enter the camera-like apartment in our eyes which give the displeasing warning "time to rise." The application of the laws of mechanics, the use of a system of levers, sets us on our daily rounds. As we rise, the springs of our beds, coiled or otherwise, react in accordance with Hooke's Law; by a system of our own levers we raise ourselves from a state of stable equilibrium to one more or less stable.

We are as yet in the first half hour of the day and have encountered many physical phenomena. We turn on the water and a steady stream of clear liquid greets us. We do not question why the liquid fills the glass or sink. Why doesn't the water run upward, or horizontally, or turn the corner, or run out of the room to go upstairs or downstairs? Obedient to the laws of liquids, it seeks its level and takes the shape of the container.

The very turning of the faucet applies the use of the mechanical device, the screw, which is used whenever it is necessary to exert a pressure or lift a weight a short distance. As we go on indulging in this refreshing liquid, we do not stop to consider that this water was pumped from some more or less distant source of supply. All the mechanism required was constructed with the greatest precision, that the efficiency be as great as possible. To avoid hammering in the pipes when the faucet is turned off, air chambers are provided. The water enters the air chamber and is brought to rest gradually as the air is compressed. This brings out the phenomena of the compressibility of gases and incompressibility of liquids.

The drain from the sink does not stand vertically but is supplied with a U-shaped pipe. This is the trap which prevents sewer gas from entering the home. Water remains in the trap

preventing the entrance of gas. Another peculiarity of this U-bend is that it acts as a siphon: the water discharges as the atmospheric pressure forces the water level in the tube to be at the same height on both sides.

The law of conservation of energy could be no better exemplified than in the energy of foods. The aroma of breakfast reaches our olfactory nerves, in compliance with the laws of diffusion of gases. As we eat our breakfast, we omit considering that the coffee was ground by application of the wheel and axle. As we raise and lower our cup, our arms are playing the part of the third class lever which has the advantage of speed.

The blessing of fresh and pure foods comes to us with the aid of the refrigerator; that silent friend of every member of the family retards the growth of bacteria in the food. By means of convection, heat of fusion of ice, diffusion, and insulation, the task is performed.

Heat transference by conduction, convection and radiation we meet early in the day. We may touch a hot pan and be burned by conduction; we draw water from the hot water tank, and convection has come into play in the process of heating the water; we warm ourselves from the heat of a fireplace by radiation.

Our daily acquaintance with physical phenomena does not lack variety:

Do we stop to think why we cover ice with a blanket to keep it from melting and remove a few layers of our blankets to keep ourselves from roasting?

We turn on the radio and start numberless electrons on errands. Do we know the radio as the work of art in the scientific field?

The telephone rings. Mechanically we answer the call, ignoring the fact that graphite particles, obedient to the vibrations of our voice, with the assistance of coils, magnets, and electricity, are carrying our message.

We hear an airplane, and we no longer wonder that man has mastered the air.

We slip, and in so doing lower our center of gravity. Our first thought is whether we were seen or not; we do not recall the idea of Newton, that every substance in the universe attracts every other substance, etc.

We admire the beauty of the sunset and its colorful setting; the phenomena of light have combined their efforts to transmit the colors of their respective waves to us.

We push a little button and the room is flooded with light. Unconsciously or subconsciously we take it for granted that the little button would produce that effect. That little button is the last in the long line of the power of a mighty falls, intricate systems of dynamos, transmission lines, transformers, tungsten filaments, argon, and a host of others that have given us the luxury of the electric light.

Physical phenomena are as much a part of our daily lives as is the air we breathe. Because of this, the study of physics ought to be regarded as the most important as well as the most fascinating, enlightening, and broadening of subjects. The more we know and understand of physical phenomena, the more we appreciate the world in which we live and the more we can accomplish for the good of our fellow man.

PROBLEM DEPARTMENT

CONDUCTED BY G. H. JAMISON

State Teachers College, Kirksville, Mo.

This department aims to provide problems of varying degrees of difficulty which will interest anyone engaged in the study of mathematics.

All readers are invited to propose problems and to solve problems here proposed. Drawings to illustrate the problems should be well done in India ink. Problems and solutions will be credited to their authors. Each solution, or proposed problem, sent to the Editor should have the author's name introducing the problem or solution *as on the following pages.*

The editor of the department desires to serve its readers by making it interesting and helpful to them. Address suggestions and problems to G. H. Jamison, State Teachers College, Kirksville, Missouri.

SOLUTIONS AND PROBLEMS

Note. Persons sending in solutions and submitting problems for solutions should observe the following instructions.

1. Drawings in India ink should be on a separate page from the solution.

2. Give the solution to the problem which you porpose if you have one and also the source and any known references to it.

3. In general when several solutions are correct, the ones submitted in the best form will be used.

LATE SOLUTIONS

1879. *Walter R. Warne, Marshall, Mo.*

1881. *Harvard D. Grossman, New York.*

1883. *Aaron Buchman, Buffalo, N. Y.*

1885. *Proposed by Alan Wayne, Flushing, N. Y.*

Find in radical form the roots of

$$(x(x-2)(x^3-4)=2.$$

Solution by M. Kirk, West Chester, Pa.

$$x(x-2)(x^2-4)=2.$$

Expanding

$$x^4-2x^3-4x^2+8x-2=0.$$

Transforming by

$$x=y+\tfrac{1}{2},\quad y^4-\frac{11}{2}y^2+3y+\frac{13}{16}=0.$$

Setting

$$(y^2+16y+r)(y^2-16y+s)\equiv y^4-\frac{11}{2}y^2+3-4\tfrac{13}{16},$$

and by equating coefficients, and solving

$$K^6-11K^4+27K^2-9=0$$

from which

$$K^2=3,\quad r=-\frac{5}{4}-\frac{\sqrt{3}}{2},\quad s=-\frac{5}{4}+\frac{\sqrt{3}}{2}\cdot$$

Hence

$$\left(y^2+\sqrt{3}y-\frac{5}{4}-\frac{\sqrt{3}}{2}\right)\left(y^2-\sqrt{3}y-\frac{5}{4}+\frac{\sqrt{3}}{2}\right)=0,$$

and by completing the solution:

$$y=\frac{-\sqrt{3}\pm\sqrt{8+2\sqrt{3}}}{2},\quad \frac{+\sqrt{3}\pm\sqrt{8-2\sqrt{3}}}{2}$$

$$x=\frac{1-\sqrt{3}\pm\sqrt{8+2\sqrt{3}}}{2},\quad \frac{1+\sqrt{3}\pm\sqrt{8-2\sqrt{3}}}{2}\,.$$

Solutions were also offered by William A. Richards, Berwyn, Ill.; B. Felix John, Philadelphia, Pa.

1886. *Proposed by Lloyd U. Wright, San Gabriel, California.*

Given the radius of a circle A, to find the radius of circle B, whose center, P, is on the circumference of A and whose arc inside A bisects the area of A.

Solution by William A. Richards, Berwyn, Illinois

Let the two circles intersect as shown in the figure. Let $\angle MPN=2x$, $\angle MON=2y$, a = radius of circle A, and b = radius of circle B. Then

$$y=180°-2x=\pi-2x,\text{ and }\sin y=\sin 2x=2\sin x\cos x,$$

also

$$2y=360°-4x=2\pi-4x,\text{ and }\sin 2y=-\sin 4x=-2\sin 2x\cos 2x.$$

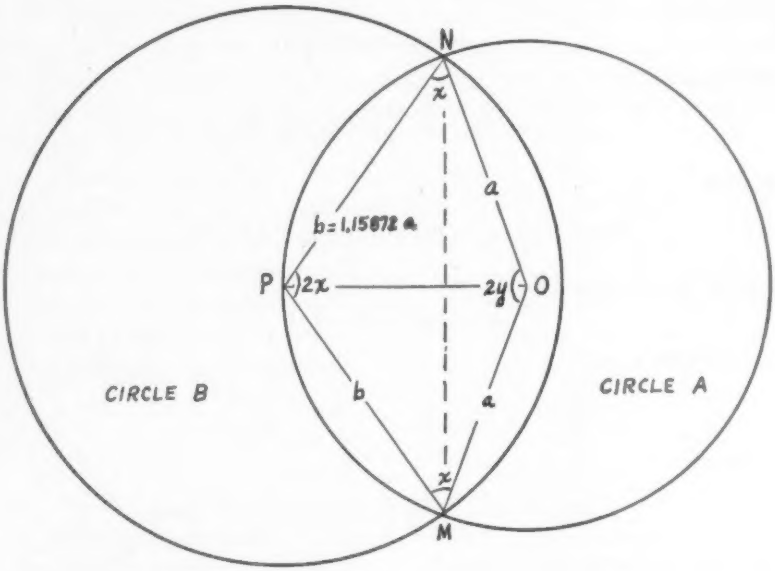
From the law of sines in trigonometry,

$$\frac{b}{a}=\frac{\sin 2x}{\sin x}=2\cos x,\quad\text{or } b=2a\cos x,\quad\text{and }\tfrac{1}{2}b^2=2a^2\cos^2 x.$$

From the hypothesis we know that the area common to A and B is $\frac{1}{2}\pi a^2$, and this common area consists of a segment of A and a segment of B. Now,

from geometry the area of a segment is given by the formula

$$A=\frac{1}{2}R(\theta-\sin\theta).$$



In circle A, $R=a$, $\theta=2y$; in circle B, $R=b$, $\theta=2x$. Hence, we obtain the equations

$$\frac{1}{2}b^2(2x-\sin 2x)+\frac{1}{2}a^2(2y-\sin 2y)=\frac{1}{2}\pi a^2, \tag{1}$$

$$2a^2\cos^2 x(2x-\sin 2x)+\frac{1}{2}a^2(2\pi-4x+2\sin 2x\cos 2x)=\frac{1}{2}\pi a^2, \tag{2}$$

$$4x\cos^2 x-2\cos^2 x\sin 2x+\frac{1}{2}\pi-2x+\sin 2x\cos 2x=0, \tag{3}$$

$$2x(2\cos^2 x-1)-\sin 2x(2\cos^2 x-\cos 2x)+\frac{1}{2}\pi=0, \tag{4}$$

$$2x\cos 2x-\sin 2x+\frac{1}{2}\pi=0, \tag{5}$$

and, finally

$$\sin 2x-2x\cos 2x=\frac{1}{2}\pi. \tag{6}$$

Equation (6) comes under the heading of approximate solutions. From the figure it is apparent that

$$90^\circ<2x<120^\circ, \quad \text{or } \frac{1}{2}\pi \text{ radians}<2x<\frac{2\pi}{3} \text{ radians.}$$

Therefore, we solve equation (6) for $2x$, by the use of five place tables. By trial we find that

$$109^\circ<2x<110^\circ, \qquad \text{or } 1.9199 \text{ radians}<2x<1.9024 \text{ radians.}$$

By making several trials between 109° and 110°, we soon find that

$$2x=109^\circ\ 11'\ 20''=1.9057 \text{ radians.} \quad \text{(A close approximation)}$$

Hence

$$x=54^\circ\ 35'\ 40''=0.95285 \text{ radians.}$$

Therefore

$$b=2a\cos 54°\,35'\,40''=\mathbf{1.15872\ a.}$$

Q. E. F.

Check:

If we substitute the values obtained in equation (1), we have

$$\tfrac{1}{2}(1.15872a)^2(1.9057-.94444)+\tfrac{1}{2}(6.2832-3.8114-1.8890\times.32868)$$
$$=\tfrac{1}{2}[1.3426(.96126)]+\tfrac{1}{2}(2.4718-.62080)$$
$$=.64529+.92550=1.57079=\tfrac{1}{2}\pi.$$

1887. *Proposed by Rita Dorner, Syracuse, New York*

If $a+b+c+d=a^2+b^2+c^2+d^2=0$, then show

$$a^8+b^8+c^8+d^8=\tfrac{1}{4}(a^4+b^4+c^4+d^4)^2$$

Solution by M. Kirk, West Chester, Pennsylvania

$$a+b=-c-d$$
$$\therefore a^2+b^2=c^2+d^2+2cd-2ab.$$

But

$$a^2+b^2=-c^2-d^2$$
$$\therefore a^2+b^2=cd-ab$$

and

$$c^2+d^2=ab-cd$$

then

$$a^4+2a^2b^2+b^4=c^2d^2-2abcd+a^2b^2$$

and

$$c^4+2c^2d^2+d^4=a^2b^2-2abcd+c^2d^2$$

or

$$a^4+b^4+c^4+d^4=-4abcd$$

but

$$(a^4+b^4)=(c^2d^2-2abcd-a^2b^2)^2$$

and

$$(c^4+d^4)^2=(a^2b^2-2abcd-c^2d^2)^2$$
$$\therefore a^8+b^8+c^8+d^8=4a^2b^2c^2d^2$$

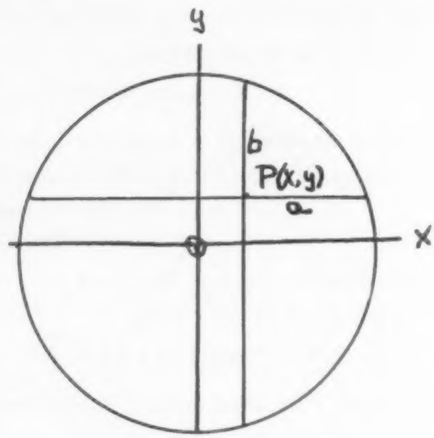
and

$$\tfrac{1}{4}(a^4+b^4+c^4+d^4)^2=\tfrac{1}{4}(-4abcd)^2$$
$$=4a^2b^2c^2d^2$$
$$\therefore a^8+b^8+c^8+d^8=\tfrac{1}{4}(a^4+b^4+c^4+d^4).$$

A solution was also offered by Wm. A. Richards, Berwyn, Ill.

1888. *Proposed by Adrian Struyk, Paterson, New Jersey.*

Two intersecting chords in a circle of radius r are perpendicular to each other. The shorter part of one is a, of the other, b. Find the distances of the chords from the center.



Solution by the proposer

Let the distances by y and x respectively. By the Pythagorean theorem,

$$x^2+(y+b)^2=r^2. \tag{1}$$

Since intersecting chords have equal segment-products,

$$a(2x+a)=b(2y+b). \tag{2}$$

Adding b^2 to both sides of (2), and squaring,

$$(2ax+a^2+b^2)^2=4b^2(y+b)^2.$$

From this and (1), after multiplying (1) by $4b^2$, and adding,

$$4b^2x^2+(2ax+a^2+b^2)^2=4b^2r^2. \tag{3}$$

The solution of 3 gives:

$$x=b\sqrt{\frac{r^2}{a^2+b^2}-\frac{1}{4}}-\frac{a}{2}.$$

$$y=a\sqrt{\frac{r^2}{a^2+b^2}-\frac{1}{4}}-\frac{b}{2}.$$

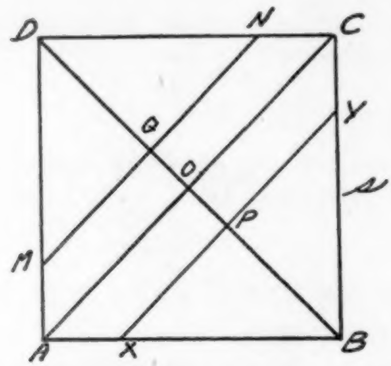
Solutions were also offered by Hugo Brandt, Chicago; M. Kirk, West Chester, Pa.; B. Felix John, Philadelphia, Pa.; W. A. Richards, Berwyn, Ill.

1889. *Proposed by Harriet Letts, Interlaken, New York.*

Trisect a given square by straight lines parallel to one of the diagonals.

Solution by B. Felix John, Philadelphia, Pa.

1. Let area of square $ABCD$ be s^2. Draw the other diagonal BD and let MN and XY be parallel to AC so that $\triangle MND=\triangle XBY=\frac{1}{3}ABCD$.
2. $\triangle MND=\frac{1}{2}DQ\cdot MN=\frac{1}{3}s^2$.
3. $\triangle DQN$ is an isosceles right $\triangle$.
4. $\therefore DQ=QN=\frac{1}{2}MN$ since $\triangle DQM$ is also isosceles right $\triangle$.
5. $\therefore \triangle MND=\frac{1}{4}\overline{MN}=\frac{1}{3}s^2$.
6. $\therefore MN=\frac{2}{3}s\sqrt{3}$ and $DQ=\frac{1}{3}s\sqrt{3}$.
7. $\therefore$ If through *pk.* Q and P on diagonal BD at a distance equal to $\frac{1}{3}s\sqrt{3}$ from D and B, lines are drawn parallel to AC, the square will be trisected.



Solutions were also offered by Milton Schiffenbauer, New York; Vanlora Bassett, Farmerville, N. Y.; Bertha Seeley, Calgary, Canada; Lelia Foote, Geneva, N. Y.; Mamie Hawkes, Halifax, Canada; Walter R. Warne; Marshall, Mo.; Grace E. Hicks, Austin, Pa.; Abbie Letts, Tramansburg, N. Y.; W. A. Richards, Berwyn, Ill.; Hugo Brandt, Chicago; and the proposer.

1890. *Proposed by Charles Bachulein, Spokane, Washington.*

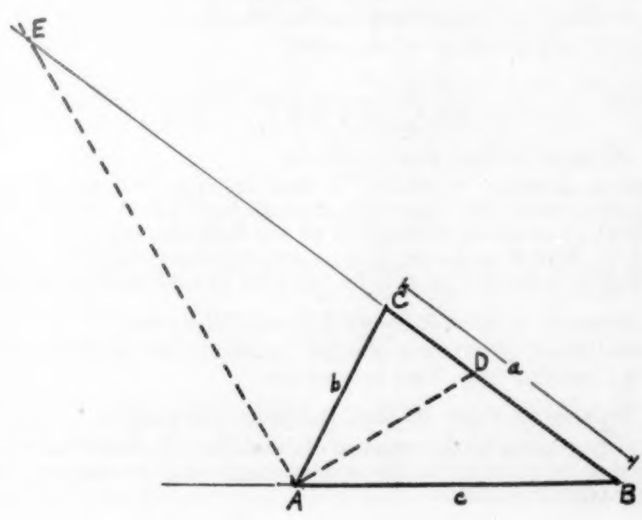
In triangle ABC, the bisectors of the interior and exterior angles at A meet BC at D and E, prove

$$DE=\frac{2abc}{c^2-b^2}.$$

Solution by William A. Richards, Berwyn, Illinois

From geometry we have the theorem—The bisector of an angle of a triangle divides the opposite side into segments proportional to the sides of the angle. Then

$$\frac{CD}{b}=\frac{DB}{c}=\frac{a-CD}{c}.$$



Therefore

$$CD=\frac{ab}{c+b}. \tag{1}$$

Also

$$\frac{CE}{b}=\frac{BE}{c}=\frac{CE+a}{c}$$

And, hence

$$CE=\frac{ab}{c-b}. \tag{2}$$

Adding equations (1) and (2), we obtain

$$CE+CD=DE=\frac{2abc}{c^2-b^2}.$$

Solutions were also offered by B. Felix John, Philadelphia, Pa.; M. Kirk, West Chester, Pa.; Walter R. Warne, Marshall, Mo.

HIGH SCHOOL HONOR ROLL

The Editor will be very happy to make special mention of high school classes, clubs, or individual students who offer solutions to problems submitted in this department. Teachers are urged to report to the Editor such solutions.

Editor's Note: For a time each high school contributor will receive a copy of the magazine in which the student's name appears.

For this issue the Honor Roll appears below.

No names appear for this issue.

PROBLEMS FOR SOLUTION

1903. *Proposed by Frank Brown, Linden, Michigan.*

Find the sum to infinity of the series:

$$\frac{3}{1.2.4}+\frac{5}{3.4.6}+\frac{7}{5.6.8}+\cdots.$$

1904. *Proposed by Hugo Brandt, Chicago.*

A rule is given for "rectifying" a small arc of a circle as follows: In a coordinate system with O as origin, draw an arc $OA=2d$, in first quadrant with $M(O, r)$ as center. Prolong chord AO back through O to B, making $OB=\frac{1}{2}AO$. With B as center, draw an arc AC intersecting the x axis in C. In calling $OC=\text{arc } OA$, what is the error for $2d=60°$ and for $2d=90°$.

1905. *Proposed by Helen M. Scott, Baltimore, Maryland.*

A focal chord of parabola $y^2=2px$, intersects the parabola in points $(9x_1, 3y_1)$ and $(x_1, -y_1)$. Find its equation.

1906. *Proposed by Helen M. Scott, Baltimore, Maryland.*

In the loop given by the equation $a^2y^2=x^3(2a-x)$, show that the circle, centered on the point of inflexion and passing through the origin, is tangent to the maximum ordinate.

1907. *Proposed by Lillie Marsh, Romulus, New York.*

For triangle ABC, show by geometry (if possible) that

$$\text{Cot } A+\text{Cot } B=\frac{c^2}{ab \sin C}.$$

1908. *Proposed by Edith M. Warne, Marshall, Missouri.*

In any right triangle ABC prove $c-b=a \tan A/2$.

BOOKS AND PAMPHLETS RECEIVED

General Chemistry, by John Arrend Timm, *Professor of Chemistry and Director of School of Science, Simmons College.* Cloth. Pages xii+692. 14.5×22.5 cm. 1944. McGraw-Hill Book Company, 330 West 42nd Street, New York 18, N. Y. Price $3.75.

They Hop and Crawl, by Percy A. Morris, *Peabody Museum of Natural History, Yale University.* Cloth. 263 pages. 15×23 cm. 1944. The Jacques Cattell Press, Lancaster, Pa. Price $3.50.

Fundamental Mathematics, by Raleigh Schorling, *Head of the Department of Mathematics of the University High School and Professor of Education, University of Michigan;* John Clark, *Professor of Education, Teachers College, Columbia University;* and Rolland R. Smith, *Specialist in Mathematics, Public Schools, Springfield, Mass.* Book One for Seventh Grade, cloth, xiv+368 pages, 13×20.5 cm. 1944. Price $1.00. Book Two for Eighth Grade, cloth, xiv+402 pages, 13×20.5 cm. 1944. Price $1.08. World Book Company, Yonkers-on-Hudson 5, N. Y.

Building Sex Into Your Life, by Paul Popenoe, Sc.D. Paper. 23 pages. 15.5×23 cm. The American Institute of Family Relations, 607 South Hill Street, Los Angeles 14, Calif. Price 25 cents.

Essential Facts About Pre-Induction Training, Prepared by the War Department in Cooperation with the U. S. Office of Education. Paper. ii+18 pages. 15×23 cm. 1944. United States Government Printing Office, Washington, D. C.

The Radio Compass, Prepared by Technical Publications Section, Engineering Department. Paper. 35 pages. 14×21.5 cm. 1944. Bendix Radio, Division of Bendix Aviation Corporation, Baltimore, Md.

BOOK REVIEWS

Atoms in Action, by George Russell Harrison, *Professor of Physics and Director of the Research Laboratory of Experimental Physics at the Massachusetts Institute of Technology.* Revised Edition. Cloth. Pages xii+401. 14×21 cm. 1944. Garden City Publishing Company, Inc., Garden City, N. Y.

For many years we have been waiting for a book of this type. Mr. Russell, a great investigator, has found time to tell of the wonderful discoveries of the modern research physicist in a manner highly interesting and entertaining for everyone. This is not a book of theory, filled with mathematical formulae, but a book of practical, common sense told in a language almost

anyone can understand. It is not a book you must read from beginning to end to learn what the author is talking about. Read a chapter or a paragraph anywhere in the book. You will then want to read the rest of it. Note a few of the chapter headings: When physics goes farming, Sound rides the wire, Light for a living world, The doctor and the physicist, Sight conquers space, Outwitting the weather, and Man climbs the winds. Unlike many books with similar titles this one was not put together just to sell. It is the work of a great scientist who realizes that only a few people have had the opportunity to learn what he tells here. A little of the book is old material to the scientist but much is "hot off the wire" for all. It is a book for every library—not one copy for each school but many copies, so that every member of the family may read, enjoy, and learn. It was first published in 1937 and the demand was so great that additional publications were made in 1938, 1939, and 1941. In this edition an entire new chapter, "Science in War and After," was added, and *The End is Not Yet.*

G. W. W.

EARTH'S ADVENTURES, by Carroll Lane Fenton. Cloth. 207 pages. 14.5 ×23 cm. 1942. The John Day Company, Inc., 2 W. 45th Street, New York, N. Y. Price $3.00.

Here is an excellent book of geology for boys and girls. It is well illustrated with many pictures and drawings, the pronunciation of many new words is indicated, and explanations or definitions are given. Short chapters on all phases of geology are given including a few pages on the solar system, some theories of the origin of the earth, and a section on shooting stars and meteorites. The last two chapters deal with historical geology. Much of the book is written in story form, the author taking his readers on an auto trip across our continent, observing and studying the country as they go. In a few instances the author errs in his statements as in the following: "It (heat) even boils tiny particles of water, sending them up into the air." Also when he first talks of the solar system he forgets about Pluto. But these are minor errors and will not even be noticed by many. It is another of the interesting books by this author that every grade school pupil should read. Books of this type will also interest older members of the family who have not had the advantages of a course in geology.

G. W. W.

HACKH'S CHEMICAL DICTIONARY, Third Edition, revised and edited by Julius Grant, London. Pages ix+925.17×24.5 cm. 1944. Blakiston, Philadelphia. Price $12.00.

This is a complete and up-to-date revision of the late Professor Ingo W. D. Hackh's well known and useful dictionary. The revision has been made by Dr. Grant whose close collaboration in the preparation of the previous editions makes him preeminently qualified to continue the work on the high level with which chemists are familiar. His close association with English usage and practice makes it possible to achieve the announced purpose of balancing the treatment between American and British points of view. This is fortunate for scientists on both sides of the Atlantic, particularly in the post-war period for it will contribute materially to mutual understanding and helpfulness.

The volume contains more than 57,000 terms generally used in Chemistry and such related sciences as Physics, Astrophysics, Mineralogy, Pharmacy, Medicine, Biology, Agricolture, and Engineering. The definitions are concise and clear. There are many helpful tables, diagrams, explanatory

illustrations, and portraits of eminent scientists. There are brief biographical accounts of a well-chosen list of chemists and contributors to kindred sciences. The object and scope of the dictionary are stated in these terms: "to provide concise definitions based on the latest research findings and current acceptations; to give a precise account of the theories, laws and rules of chemistry; to describe the elements, compounds, drugs, minerals, vegetable and animal products; to list concisely the reactions, processes and methods; to mention the apparatus, instruments, equipment of chemistry; to note the names of investigators who have built up the science."

The publishers have done a good job in spite of war-time difficulties. The volume is not cumbersome, thanks to the use of thin paper; the type is clear and readable and the binding is sturdy, vermin-proof, water resisting and cleanable with soap and water. If one were to look for short-comings they would be difficult to find. The thin paper permits the type of the next page to "show through" to a minor extent. The half-tone portraits are not clear. But these defects are quite insignificant in comparison with the excellent workmanship and the complete mastery of transocean, war-time difficulties. Some users of former editions may regret the omission of pronunciations, made to save space and in deference to the chaotic practices in various localities. The reviewer hopes that pronunciations will be restored in future editions, because science is badly in need of a carefully prepared list of pronunciations, and so popular and authentic a book as Hackh's dictionary should be able to take the lead in this reform. If such a plan makes necessary additional conservations of space, the author might consider the omission or abbreviation of biographical material, since we do not ordinarily consult a dictionary for such information.

Hackh's third edition is a splendid and helpful volume. It will be useful to science workers and to those who are interested in scientific progress and terms.

B. S. Hopkins
Urbana, Illinois

Physics of the 20th Century, by Pascual Jordan. Translated by Eleanor Oshry. Cloth. Pages xii+185. 13.5×21.5 cm. 1944. The Philosophical Library, Inc., 15 East 40th Street, New York 16, N. Y. Price $4.00.

"This book tries to present the concepts of modern physics in a systematic, complete review. The reader will be burdened as little with details of experimental techniques as with mathematical formulations of theory. Without becoming too deeply absorbed in the many, noteworthy details we shall direct our attention toward the decisive facts and views, toward the guiding viewpoints of research and toward the enlistment of the spirit, which gives modern physics its particular philosophical character, and which made the achievement of its revolutionary perception possible."

The foregoing quotation—the opening sentences of the preface—promises more than this small book fulfills. The review which is presented is systematic, but it is very far from complete. The book begins with the classical mechanics of Galileo and Newton, briefly discusses the electrodynamics of Maxwell, and leads from a description of atomic theory to the modern quantum theory—a field in which Professor Jordan has made important contributions. But though the plan of the book is good, it is too brief to satisfy the reader who hopes to gain from it some understanding of present-day physics.

In his endeavor not to burden the reader with details the author quotes the results of experiment without any indication of how they were obtained; it is doubtful whether the meaning of the results will be clear to

the intelligent but nonscientific reader who is first introduced to them in this book. A more comprehensive and more lucid description of the findings of modern physics is given, for instance, in Harrison's *Atoms in action.*

In his final chapter the author endeavors to set forth the changes that modern physical theories have forced upon philosophy. He discusses the effect of the idea of indeterminancy introduced by quantum mechanics and suggests that the reactions of a living organism "possess an element of fundamental incalculability and unpredictability" because they are controlled by reactions on a microphysical scale. He urges the positivist point of view, according to which "experimental observations and experiences are the sole 'reality' for the physicist," but points out also that there are experiences which cannot be expressed in scientific terms. Here again, however, the author, perhaps in his endeavor to be brief, falls short of the clarity of such a book as Jeans' *Physics and philosophy.* There are two appendixes, on cosmic radiation and on the age of the world as determined from radioactivity.

The German version of which this is a translation was published in 1936. The translation appears to be accurate but it is somewhat too literal; it is not always idiomatic and it has the rather ponderous quality of the German. There is no index.

JOSEPH D. ELDER
Wabash College

OUR AIR-AGE WORLD, by Leonard O. Packard, *Head of the Department of Geography, Teachers College, of the City of Boston,* Bruce Overton, *formerly of the Male High School, Louisville, Kentucky,* and Ben Wood *Columbia College, Columbia University.* Cloth. Pages x+838. 24×15.5 cm. 1944. Numerous illustrations, maps, graphs and statistical tables. Bibliography. The Macmillan Company, New York. List price $2.80.

This book is organized in eight parts, the first consisting of six units, the second of eight units and the remaining six of one unit each. The parts are as follows: Part I. "Global Geography," Part 2. "The United States in a Global War," Part 3. "The Other Americas," Part 4. "Europe, A Continent in Turmoil," Part 5. "Asia, A World Problem," Part 6. "Lands Down Under," Part 7. "Africa, An Air-Age Crossroad," Part 8. "The World of Tomorrow."

Throughout the book the material is geared closely to the present world conflict. The illustrations are up to date as to bombers, tanks, training planes, antitank guns, antiaircraft guns and the like. The weather study of low and high pressure areas is clear but omits the warm and cold fronts so important in present weather forecasting. The wide use of the polar map indicates the authors' ideas concerning polar routes.

There are many worthwhile industrial illustrations and clear black and white diagrams. The tables of statistics in the appendix are ample but need some additions in the per capita production for comparative uses. The book has abundant factual material for the present world war crisis.

VILLA B. SMITH

ORGANIC CHEMISTRY FOR THE LABORATORY, by C. W. Porter and T. D. Stewart, *Professors of Chemistry, University of California.* Cloth. Pages xi+222. 14×20 cm. 1943. Ginn and Company, Boston, Massachusetts. Price $2.00.

An examination of this compact laboratory manual in organic chemistry reveals that Professors Porter and Stewart have succeeded in compressing

into it a remarkably large amount of subject matter, as much as most texts of twice the size and price.

The book provides enough experiments for the usual two-semester course or for a very complete first semester. Experiments cover both the test tube variety to illustrate reactions of various classes of compounds and also preparations designed to teach the student laboratory technique as well as theory. The emphasis is somewhat on the synthetic side, and rightly so, in the reviewer's opinion. The choice of synthetic experiments ranges from the important similar types such as replacement of groups, esterification, oxidation, reduction, substitution, etc., through experiments on dyes, the Friedel-Crafts reaction, and condensations and rearrangements such as the Perkin reaction and the Beckmann rearrangement.

Each experiment is preceded by a brief theoretical discussion of the chemistry involved. Optional experiments, derivatives, and analytical tests are often included and many of the experiments are provided with problems and questions.

Only one omission has been noted which may cause inconvenience for some teachers. No experiments have been included on the chemistry of the proteins, although the carbohydrates are thoroughly covered.

Approximately one-fourth of the text is devoted to a treatment of mechanical operations such as distillation, filtration, etc. This whole section seems excellent in content and in presentation, and should be of much value to both teachers and students.

The book makes a worthwhile addition to the list of laboratory manuals in use throughout the country.

ROBERT L. FRANK
University of Illinois

VITAL MATHEMATICS, by Edwin Brown Allen, *Head of The Department of Mathematics, Rensselaer Polytechnic Institute, Troy, N. Y.*, Dis Maly, *Instructor in Mathematics, Rensselaer Polytechnic Institute*, and S. Herbert Starkey, Jr., *Head of Mathematics Department, Madison High School, Madison, N. J.* Cloth. Pages vii+456+xxii. 15×22 cm. The Macmillan Company, New York. Price $1.80.

This book was written to provide training in the fundamentals of the mathematics commonly taught in the common and high schools. It deals with arithmetic, algebra, plane and solid geometry, statistics and trigonometry but only selected parts of each subject. Emphasis is on *how* processes are performed rather than on *why* they are done in the way they are, although there is sufficient logical development for a book of the type the authors are presenting. The book is aimed specifically at the teaching of those skills needed in industry and military experience. It is addressed to those studying without an instructor as well as those studying in classes. It would provide suitable material for use in the last two years of the high school in classes made up of those who had had limited training in mathematics and desired to make preparation for practical applications of the subject. There is an abundance of problems, answers to which are given. Logarithms and the slide rule are presented and there are adequate tables.

WALTER H. CARNAHAN
Purdue University

PLANE AND SPHERICAL TRIGONOMETRY, by William C. Brenke, *University of Nebraska.* Cloth. Pages x+269. 14.5×21 cm. 1943. The Dryden Press, Inc., 103 Park Ave., New York. Price $1.90.

This text is a complete rewriting of *Elements of Trigonometry* by the

same author. Account has been taken of the present day demands for mathematics that functions in aeronautics, navigation, and military needs. And yet these applications have not geen permitted to dominate the work not to obscure the purpose to treat trigonometry as an integral part of the sequence of subjects that make up pure mathematics. As a connection between trigonometry and other mathematical subjects to follow, the author introduces such analytic topics as the exponential expressions for the functions, hyperbolic functions and DeMoivre's Theorem. Spherical trigonometry is treated in two chapters, culminating in applications to navigation and astronomy.

First definitions of the trigonometric functions are in connection with ordinate, abscissa and distance, definitions relating to the right triangle following the more general definitions. The text assumes that learners are acquainted with the use of logarithms, but a complete teratment of the subject is placed in the appendix for the convenience of those who must relearn the subject or who have not previously mastered it. There is a nice balance between numerical applications and analytic trigonometry. Answers are provided to odd numbered problems. The format of the book is excellent. Logarithmic tables are four place, and trigonometric tables are for ten minute intervals.

WALTER H. CARNAHAN

SPHERICAL TRIGONOMETRY WITH TABLES, by Donald H. Ballou, Ph.D. *Assistant Professor of Mathematics, Middlebury College*, and Frederick H. Steen, *Associate Professor of Mathematics, Allegheny College*. Cloth. Pages iv+68+4+84. 14.5×22.5 cm. 1943. Ginn and Company, Statler Building, Boston, Mass. Price $1.25.

The text is reprinted from *Plane and Spherical Trigonometry* by the same authors. The subject of spherical trigonometry with its applications to problems of navigation is fully treated. Haversines are extensively employed. There is an abundance of exercises, problems and worked examples. Answers are provided to all problems. There is a summary of the formulas of plane trigonometry and a review of the principles of logarithms. Logarithmic tables are five place, and trigonometric tables give values of the ratios for every minute.

Format and general appearance of the book are good. Figures are well drawn and the pages are not crowded.

WALTER H. CARNAHAN

RIDDLES IN MATHEMATICS, A BOOK OF PARADOXES, by Eugene P. Northrop. Pp. viii+262. 1944. D. Van Nostrand Company, Inc. New York. Price $3.00.

The book contains a large number of mathematical riddles and paradoxes most of them familiar to the advanced students of mathematics. While the materials are gathered from a variety of sources, listed with notes for each chapter at the end of the book, the main sources are the well known books by Ball; *Mathematical Recreations and Essays;* Steinhaus, *Mathematical Snapshots;* and Kasner and Newman, *Mathematics and the Imagination.* It is to be expected, of course, in a book of this nature that very little is original with the author. However, he has made a worthy c ntribution in presenting a book written in a pleasing style which will appeal not only to the people, who "weary of the complexities of the human equation in everyday activities, turn in their leisure to the simplicities of the mathematical equation," for whom the author claims the book to be written, but, in the opinion of the reviewer, will also appeal to the

student of mathematics who may be interested in the abstract aspect of the subject. He, too, will find pleasure to reread the familiar riddles and paradoxes.

The book will doubtless make its contribution to increase popular interest in mathematics.

J. S. GEORGES
Wright Junior College, Chicago

MATHEMATICS FOR MARINERS, by Chester E. Dimick, *Captain USGG;* and Cuthbert C. Hurd, *Lieutenant, USCGR, United States Coast Guard Academy, New London, Conn.* Pp. vii+253. 1943. D. Van Nostrand Company, Inc. New York. Price $2.75.

This text has been prepared by the authors on the basis of their experience in teaching classes of candidates for Reserve Commissions at the Reserve School of the United States Coast Guard Academy. Consequently, it contains what is believed by the authors to be the basic mathematics necessary for plane navigation, simple gunnery, seamanship, maneuvering at sea, and elementary marine engineering.

The first three chapters are devoted to numerical and logarithmic calculations. The next two chapters consist of selected topics in algebra and plane geometry. The following three chapters are devoted to plane trigonometry. Vectors and relative motion are treated in the last two chapters. Tables of logarithms and of trigonometric functions are included.

The presentation follows the purposes stated in the preface. Applications are given to illustrate mathematical concepts and processes. Practical problems essential to the training of mariners are solved by methods which experience has shown to be effective.

J. S. GEORGES

BASIC MATHEMATICS, by Paul H. Daus, *Professor of Mathematics, University of California, Los Angeles;* John M. Gleason, *Assistant Professor of Mathematics, San Diego State College, San Diego;* and William M. Whyburn, *Professor of Mathematics and Educational Supervisor, ESMWT, University of California, Los Angeles.* Cloth. Pages xi+277. 13.5×21.5 cm. 1944. The Macmillan Company. New York. Price $2.00.

This book is intended to meet the mathematical needs of those in the armed service, and in war industry. It is based on the supposition that these needs are met better by presenting instructional materials which are standard materials of arithmetic, algebra, geometry, and trigonometry. Consequently, Chapter I is devoted to a review of Arithmetic; Chapter II presents the fundamental concepts and processes of elementary Algebra; Chapter III includes selected theorems from Plane Geometry; Chapter IV considers elementary Trigonometry; and in Chapter V are presented certain topics from Solid Geometry, with emphasis on the sphere and spherical triangles.

The outstanding educational feature of the text is the applications of the selected topics in each chapter to practical problems, varying from calculating machines to vectors and navigation.

J. S. GEORGES

BIOLOGY AND MAN, by Benjamin C. Gruenberg, *Consultant of Social Security; Formerly Chairman, Biology Departments, Commercial and Julia Richman High Schools, New York City;* and N. Eldred Bingham,

Horace Mann-Lincoln School, Teachers College, Columbia University. Cloth. Pages viii+719. 16.5×23.5 cm. 1944. Ginn and Company, Boston. Price $2.24.

In this secondary school text the authors have adopted a new approach to the study of biology by centering the attention on man, himself. The authors have sought to depict life in terms sufficiently broad to include man and sufficiently concrete to be within the grasp of the common mind. Each unit and each chapter of the book starts with a number of questions designed to represent in the experiences of all, the common curiosities and wonderings of young people. At the end of each chapter the important points considered are briefly summarized, followed by a series of questions which the authors assume will have new meanings, explore new understandings and stimulate thinking in interpreting meanings. The authors have also included at the ends of the chapters numerous "explorations and projects," through which students may obtain experience in organizing material to guide and check their thinking.

The text contains a wealth of new information, attractive and well selected illustrations and is written in an interesting style, all of which have created a text that should have an absorbing appeal to students at the secondary school level. Some understanding of the nature of the text may be gained from a consideration of the titles of each unit. In addition to the introduction, You and Biology, the titles of the units are: I—What is Life? II—Under What Conditions Can We Live? III—How Do Living Things Keep Alive? IV—How Do the Parts of an Organism Work Together? V—How Do Living Things Originate? VI—How Did Life Begin? VII—Why Cannot Plants and Animals Live Forever? VIII—What Are the Uses of Biology? Man the Creator. An illustrated classification of plants and animals is included under Appendix A, and a comprehensive list of supplementary readings grouped under each unit is included under Appendix B.

The material is well organized and presented and should be well received by teachers and students of biology.

H. C. Nelson
Wilson Junior College, Chicago

Elements of Biology, by Perry D. Strausbaugh, *Professor of Botany, West Virginia University* and Bernal R. Weimer, *Professor of Biology, Bethany College, West Virginia.* Cloth. Pages viii+461. 14.5×21.5 cm. 1944. John Wiley and Sons, 440 Fourth Avenue, New York, 16, N. Y. Price $3.25.

This book is a shortened version of the authors larger textbook, *General Biology,* and is designed for use with a one semester course in billogy. A few changes have been made. The first chapter attempts to point out the relationship of biology to the other fields of science, and to develop some of the broader aspects of the practical applications of biological principles. The problem of correlation in the organism is presented under two headings: chemical correlation and nervous correlation. The authors have placed much less emphasis on classification and morphology in this text.

The material is well organized and presented. The text is provided with an abundance of well selected illustrations, many of which are colored. As in the older text the authors have emphasized the basic principles of biology and have attempted to provide the student with a body of knowledge which will be most useful to him.

H. C. Nelson

UNABATED

Present trends show that the school crisis of 1942–43 is continuing in 1943–44 without abatement. Teacher turnover or replacement continues to be double its normal rate. Thousands are leaving the profession and their positions are left vacant, eliminated, or filled by persons with less than standard qualifications. Salary improvements, relatively small in amounts, have come too slowly and have still failed to reach thousands who are working for substandard payments.

These trends are revealed in a statement of estimates just issued by the NEA Research Division and based on data collected in cooperation with the U. S. Office of Education. The statement continued:

"The outlook for 1943–44, as of September 1943, is that 254,000 teachers will be paid less than $1200; 44,000 will receive less than $600. Thus in a total of 882,450 teachers nearly thirty in every hundred will be below $1200; five in every hundred will be below $600. Last year 360,000 received less than $1200 and 66,000 received less than $600 . . . .

"In 1943–44 more than 170,000 teachers will be new to their positions as compared with a turnover of 180,000 in 1942–43 and a normal annual replacement of about 90,000 . . . .

"Teacher turnover does not measure the number of persons leaving the profession since many 'new' teachers have shifted from other school systems. Last year the profession lost an estimated total of 39,000 teachers who entered the military services; this year the expected loss will be 29,000. In 1942–43 apparently 37,000 teachers entered war industries and similar non-teaching employment; in 1943–44 about 25,000 are expected to leave for similar reasons. The total number leaving because of military service, other employment, marriage, death, and other factors is expected to reach 80,000 teachers.

"How will this gap be closed? In the first place 10,000 positions have been eliminated and 8,000 other positions are vacant (in October). Thus there are 62,000 positions that have been filled by recent graduates of teacher-education institutions and persons holding emergency credentials. In September 1943 more than 40,000 emergency certificates had been issued and by October the number had risen to 50,000. Educational institutions, which normally supply about 50,000 new teachers each year, probably supplied about 10,000 persons.

"In brief then the schools will be short this year at least 68,000 qualified teachers (total of vacancies, eliminations, and emergency certificates).

"The potentially most destructive development is the decline of teacher education. In 1940–41 the teachers colleges enrolled 175,000 regular students; in 1942–42 a total of 146,000; in 1942–43 a total of 113,000; and in 1943–44 an estimated total of 72,000 (not including military students). These institutions have declined 60% of their prewar enrollments. In the same period the number of emergency credentials has increased from 2300 to 50,000—an increase of 2,000%."

SIGHT FOR RIFLE GRENADES

For more accurate lobbing of rifle grenades, R. O. Persinger of Marion, Ohio, has devised a simple sight, easily attached to or detached from the rifle, for which he has received patent 2,335,881. A horizontal sighting arm carries front and rear sights. Projecting downward from it is a graduated segment with a pointer to indicate the relatively high angles at which it is necessary to hold a rifle during grenade firing.

The inventor has assigned to the U. S. government rights to manufacture and use his device without payment of royalty.

Photo by courtesy of the College of the City of New York where more than 4000 students have been trained in various war industry courses during the past two and one-half years.

The three R's *become E. S. M. W. T.**

Universities and schools are training thousands of young men and women under the E.S.M.W.T.* program of the United States Office of Education.

Typical is the young woman shown above who is measuring the refractive index of a prism with a Spencer Spectrometer—part of a training course which will qualify her as an inspector or production worker in an optical instrument plant.

Thus our modern educational institutions are equipping the youth of the nation for scientific work in war production—a far cry from the little red schoolhouse of early America!

ARMY E NAVY

Spencer LENS COMPANY
BUFFALO, NEW YORK
SCIENTIFIC INSTRUMENT DIVISION OF
AMERICAN OPTICAL COMPANY

**E. S. M. W. T.— Engineering, Science, Management, War Training.*

SYNTHETIC MENTHOL WHICH RESEMBLES NATURAL PRODUCT IN CHEMICAL STRUCTURE PRODUCED FROM THYMOL

Synthetic menthol which resembles natural menthol in its chemical structure can be produced commercially from thymol. Drs. H. B. Hass and A. L. Barney of Purdue University developed the new method of producing menthol artificially.

The synthetic menthol has the same taste and odor as natural menthol, and pharmaceutical differences, if any, are slight. The new process is one of distillation, beginning with thymol hydrogenated to a complex mixture of alcohols and ketones. Menthone is produced first, and this is then reduced to synthetic menthol.

Thymol is found in oil of thyme, of which there is no particular shortage at the present time. Natural menthol is found mainly in the Orient.

WATER IN LAKES, RIVERS LESS THAN UNDERGROUND

The underground supply of water in the United States available for domestic and industrial purposes and irrigation is more extensive than in all the lakes, rivers and other reservoirs, with the possible exception of the Great Lakes.

"With proper care in withdrawals," W. N. White of the U. S. Geological Survey stated recently, "this supply will last forever." But unless the supply is properly handled, he explained, if the pumping level is allowed to fall too low, there is danger of exhaustion.

When the pumping level falls too low, the fresh water sands in some areas may become contaminated by brackish or salty water. This is already occurring in some Gulf Coast areas.

MACKENZIE RIVER OIL FIELD

To help supply oil and gasoline for the United States and Canadian armed forces in the Alaskan zone, oil wells are being tapped just south of the Arctic Circle on the Mackenzie River.

The United States and Canadian governments are together developing oil wells at Fort Norman, 125 miles south of the Arctic Circle. Wells were first drilled here in 1921, but were not used until early in the thirties. Today this is the center of a great wartime drilling development. The joint government development is known as the Canol project, Canol standing for Canadian Oil.

NEW RESIN PLASTIC USED TO REMOVE HAIR FROM HOGS IN PACKING PLANTS

Traditional hog-scalding to remove the hair in butchering may soon be "out," replaced by a new scientific method. In the new process porkers are plasticized and peeled. The dead hog is submerged in a tank of liquid plastic, then pulled out coated with the sticky stuff. When properly cooled, the plastic is stripped off, taking all the hair with it. The process is quick, clean, thorough and economical.

The plastic used is a resin chemical. After being used on one hog it is remelted and used again and again. Bristles, whiskers, stubble and hairs are removed from the liquid before it is re-used. They are just as suitable for commercial uses as if they had been removed by the old scalding-scraping method. The new chemical shaving method, and the resin chemical used, were developed by the Hercules Powder Company.

AMERICAN COMMERCIAL RADIO STATION, OPENED IN ITALY FEB. 1

The first American wholly-owned commercial radio station in Europe, opened in Italy on Feb. 1, it is now revealed, transmitted over 800,000 words to the United States during the first month in operation. These included many thousands of messages from service men to their homes, and news copy from American correspondents to their papers. The daily capacity of the station is more than 75,000 words.

This overseas two-way radio station was erected by the Radio Corporation of America Communications, Inc., (RCAC) at the request and with the cooperation of the U. S. Army, to relieve military communication channels and to handle news copy and individual messages from soldiers and sailors. The radio-beamed messages travel directly 4,300 miles across land and water to the giant RCAC receiving station at Riverhead, Long Island, and from there automatically by land lines to the company's office at New York.

This station in Italy was erected by engineers of the company in less than a month from scratch to finish. It is now sending on-the-spot news at a rate as high as 240 words a minute. American correspondents find that dispatches, after being passed by the censors, reach home offices in a very short time. Flash copy and urgent bulletins often make the journey in as little as three minutes.

PLASTIC EYES DEVELOPED

Plastic eyes are being successfully produced in this country. Equalling glass eyes in popularity, they have the advantage of being non-explosive. In rare instances a glass eye has exploded due to temperature changes.

Before the war practically all artificial eyes were blown from a special glass, with a velvety texture, that could be secured only from a small town in Germany. Today the German monopoly has been broken and the material for glass as well as plastic artificial eyes are being made in America.

NEW ENGLAND ASSOCIATION OF CHEMISTRY TEACHERS SIXTH SUMMER CONFERENCE

The Sixth annual summer conference of the N.E.A.C.T. is scheduled for the last week-end in August, Thursday evening to Monday noon, August 24–8, inclusive. It will be held at Connecticut College, New London, Connecticut. The program will be centered about two main themes: (1) a symposium on oxidation-reduction, and (2) recent developments in various fields of chemistry. Consideration will also be given to postwar teaching problems in the sciences.

POSTWAR JOBS IN PLASTICS

Anyone who is considering the Plastics Industry as a possible field for postwar employment will find helpful information in a six page folder on *Occupations in Plastics* by Max Alpert, just published by Occupational Index, Inc., New York University, New York 3, N. Y. Single copies are 25¢, cash with order.

The folder includes brief descriptions of 15 different jobs. In concise form it states the abilities and preparation required, the methods of getting a job, average earnings, and the principal manufacturing areas. For those who wish more detailed information, the 4 best books have been selected from 58 sources examined in preparing the abstract.

This is the sixth in a new series of *Occupational Abstracts* covering fields in which postwar employment prospects are favorable. The subscription price for the series is $2.50 a year.

YELLOWSTONE'S MORNING GLORY POOL GOES ON RAMPAGE

Placid Morning Glory Pool, known to practically all visitors to Yellowstone National Park as one of the most beautiful hot springs in the entire area, went berserk the evening of June 10, pushing water toward the highway to a depth of about one foot. Superintendent Edmund B. Rogers of the park reports that four fishermen returning from the Firehold River below the pool came upon the flood and reported it to the Old Faithful Ranger Station. Investigation disclosed the overflow of the erstwhile quiet pool. The park office has no record of Morning Glory Pool previously throwing any such tantrum.

While the cause of the eruption is not known, it may have been an internal reaction to the large amount of debris that thoughtless visitors had thrown into the water from time to time; for handkerchiefs, towels, tokens, pennies, automobile hubcaps, stewpans, cans, combs, smoking pipes, pens, pencils, and other peculiar items were in the debris suddenly disgorged. Since the trees in the immediate vicinity had not been touched, the water apparently was pushed out rather than thrown to any great height.

Clearing the throat of the pool of the up-chucked matter lowered the water level some 10 to 12 feet. Within two days of the eruption, however, the pool was running over at its normal rate, the water still quite cloudy. Indications are that the water will clear itself again and the pool resume the even tenor of its way.

18 "ALL-STAR" ARTICLES ENCORED FOR ANNIVERSARY

About 18 of the finest and most enduring of the 1,000 articles that have appeared within the past 8 years in *The Clearing House*, a Journal for Modern Junior and Senior High School Faculties, will be reprinted in the magazine's 25th Anniversary Issue, October 1944, announces Dr. Forrest E. Long, editor.

All regular departments will be omitted, and the issue increased to 24 pages over normal size, to allow a varied, balanced anthology covering some of the best thinking and achievement-reports dealing with current secondary-education problems.

Selection of the "all-star" articles was based upon balloting by *The Clearing House* board of 42 editors and associate editors, and also by an unselected 33 per cent of subscribers who were polled. Records of reader response on the various articles, and their reported usefulness in the high schools, were deciding factors in the final selection.

The October Anniversary Issue is being reprinted as a paper-bound professional book, to make it available to non-subscribers, faculty discussion groups, and secondary-education classes. The reprint is 75 cents a copy, and may be ordered from *The Clearing House*, 207 Fourth Ave., New York 3, N. Y.

CENTRAL ASSOCIATION OF SCIENCE AND MATHEMATICS TEACHERS, INC.

APPLICATION FOR MEMBERSHIP

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I hereby apply for membership in Central Association of Science and Mathematics Teachers, Inc., and enclose $2.50 as annual membership dues, which includes a year's subscription to School Science and Mathematics (published monthly October to June inclusive).

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Mail this application with $2.50 (Foreign countries $3.00) to Ray C. Soliday, Box 408, Oak Park, Illinois.

THE READING CLINIC

The Reading Clinic Staff of the School of Education, The Pennsylvania State College, State College, Pennsylvania, is sponsoring two important meetings on reading problems during 1945.

The Annual Seminar on Reading Disabilities will be held from January 29 to February 2, 1945. Demonstrations and discussions on a differentiated program for analyzing and typing, or classifying, reading disabilities will be conducted by the Staff of the Reading Analysis Unit of the Reading Clinic. Remedial techniques will be demonstrated and discussed by the staff of the Reading Clinic Laboratory School. A number of visiting speakers and demonstrators have been included. The program has been planned to interest remedial teachers, school psychologists, speech teachers, neurologists, otologists, and vision specialists.

From June 26 to June 29, 1945, The Reading Clinic Staff will conduct the Annual Conference on Reading Instruction. This conference deals with classroom problems. The activities are differentiated for elementary and secondary teachers, college teachers, special class teachers, speech teachers, and school psychologists.

Copies of the program and information on transportation schedules may be obtained from Miss Betty J. Haugh, Reading Clinic Secretary. Those desiring college credit, especially Graduate School credit, for the seminar should register in advance with the Director of the Reading Clinic.

Lightweight lifeboats, economical and easy to build in large numbers and requiring little metal, are constructed of plywood. Keel and frame are made of solid wood. The plywood shell is held by metal stem and stern posts.

X-RAYS CHANGE CRYSTALS' VIBRATION RATES

X-rays can be used to bring about changes in the rates of oscillation or vibration in the quartz crystals used in the control of radio transmitters, precision clocks and other critically accurate apparatus. Dr. Clifford Frondel, of the Reeves Sound Laboratories in New York City, told the meeting about the method and its usefulness.

Intense irradiation of the quartz plates, he said, changes their color from clear to smoky and at the same time reduces their vibration rate. This reduction may be on the order of from 500 to 3,000 cycles per second in the frequency range from five to nine megacycles. The practical use of the method is in "tuning" the plates, doing away with the necessity for extremely precise cutting hitherto necessary to get a given wave length. The change is reversible; baking at about 175 degrees Centigrade will restore original color and vibration rate.

CENTRAL ASSOCIATION OF SCIENCE AND MATHEMATICS TEACHERS, INC.

APPLICATION FOR MEMBERSHIP

Date ....19.........

I hereby apply for membership in the Central Association of Science and Mathematics Teachers, Inc., and inclose $2.50 for annual membership dues, which includes one year's subscription to SCHOOL SCIENCE AND MATHEMATICS. I will receive nine issues of this journal, none being published in July, August or September. (Subscriptions beginning with January issue expire with December; with October issue expire with June.)

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